INSTRUCTION BOOK

for

RADIO NAVIGATION EQUIPMENT MODEL DAS

and

MODEL DAS-2

SHIPS 225A

CONFIDENTIAL

(Non-Registered)

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Subj: Operating and Maintenance Note - Models DAS and DAS-2 Radio Equipment

1. General. Faulty adjustment of the voltage regulator circuits in subject equipment can cause several undesirable operating conditions. This is especially true after modification of the equipments to improve the action of the Balance circuits. The undesirable features are:

(1) Introduction of slight jitter in lower trace on sweep 4 and 5.

(2) Variation in position of markers on the lower trace on sweep 4 and 5, by movement of balance control and to a lesser extent the gain control.

2. Operating. The variation in position of markers on the lower trace and consequent change in the reading, as mentioned in paragraph 1. (2) above, will not cause an error in the reading provided the gain and balance controls are not moved to change the amount of shift after signals have been matched, but may cause errors in using homing technique if not carefully watched. Therefore, operators should be instructed:

(1) To get in the habit of not changing the gain and balance controls after matching signals and before reading, and to carefully check readings when homing.

(2) To check for movement of the markers on the lower trace or sweep speed 4 with variation in the position of the gain and balance controls, and to report this to proper maintenance men for correction at an early opportunity. (However, note that even with this movement the equipment is entirely usable.)

3. Maintenance. The faulty performance mentioned in paragraph 1 above can be minimized by adjustment of the voltage regulator (R309) to produce a regulated B+ voltage ("+300") of 280 volts rather than 300 volts, and by checking that the voltage regulator is actually operating.

4. This note does not apply to Models DAS-1, DAS-3 or DAS-4 equipment.

INSTRUCTIONS
FOR THE
INSTALLATION OF MODIFICATION KIT M FOR MODEL DAS AND DAS-2 EQUIPMENTS

NOTICE

A. When the modifications described here have been incorporated, the following changes should be stamped on type and model nameplates of the modified equipment:-

(1) DAS-a (DAS with PRR switch) becomes DAS-aM and Receiver-Indicator CG-46210-A becomes CG-46210-C.

(2) DAS-b (DAS-a with 4 low frequency channels) becomes DAS-bM and CG-46210-B becomes CG-46210-D.

(3) DAS-2 becomes DAS-2M, CG-46210-A becomes CG-46210-C and Indicator CG-55147 becomes CG-55147-A.

(4) DAS-2b (DAS-2 with 4 low frequency channels) becomes DAS-2bM, CG-46210-B becomes CG-46210-D, and CG-55147 becomes CG-55147-A.

B. For proper operation of the modifications described here, it is assumed that the four previous modifications (Group I to IV) have been made on the DAS or DAS-2. See Supplement E to Preliminary Instruction Book (SHIPS 225).

Prepared by

Radiation Laboratory
Massachusetts Institute of Technology

for

U. S. Navy Department Bureau of Ships

February, 1945

INSTRUCTIONS FOR THE INSTALLATION OF KITS TO PRODUCE 2 MICROSECOND MARKERS IN MODEL DAS & DAS-2 EQUIPMENT

A. General

When DAS or DAS-2 Equipment is used for monitoring Loran signals it is desirable to have a smaller sub-division of time than 10 microseconds. This requires new marker-generating equipment and means of expanding the fast sweep. The unit for generating new markers spaced 2 microseconds apart is fully assembled. This assembly consists of a 6SL7 tube and associated circuits. One half of the tube acts as a times five (x5) multiplier, multiplying the 100 kc. sine wave of the crystal oscillator to 500 kc. The second half of the tube is used as a clipper which allows only a small portion, or top, of the 500 kc. waveform to pass. Expansion of the fast sweep is obtained by modification of the existing sweep circuit, and is outlined fully below.

B. Contents of Modification Kit M

1 Marker unit, assembled, with leads.

1 Type 6SL7GT duo-triode tube.

1 Replacement potentiometer for fine delay (R338).

1 Toggle switch, bat handle, SPST.

1 100,000 ohms, 1 watt, carbon resistor.

1 330,000 ohms, 1 watt, carbon resistor.

1 6.8 megohms, 1/2 watt, carbon resistor.

1 500 μμf mica capacitor, ±5%, 500 volt.

1 19" length of shielded single-conductor cable (approx. 36 μμf per ft.)

1 17" length of shielded two-wire cable.

1 Set of instructions.

1 3/8" rubber grommet.

1 12" length of lacing cord.

1 Bracket for mounting terminal board #111.

C. Additional Equipment Required, But Not Supplied

1 Item #41 of DAS spare parts (or Item #68 of DAS-2 spare parts).

1 Item #61 of DAS spare parts (or Item #88 of DAS-2 spare parts).

D. Installation of Generator

1. Remove the center panel from the front of the cabinet and withdraw the Indicator Unit.

2. Facing the rear of the Indicator remove terminal board #111 and potentiometer #R143.

3. Locate position of Marker Unit, and mark position of holes for mounting, and hole for 3/8" grommet. (See photographs in Fig. 6 and 7 for proper positions).

4. Drill these three holes.

5. Install single shielded cable through grommet and carry forward to L102.

6. Again face the rear of the Indicator. Using the left hand mounting hole for R143 and a hole 2 inches to rear, install small bracket and R143.

7. Mount terminal Board #111 on this bracket.

8. Make connection of shielded cable to 50 μμf. coupling capacitor and ground shield to the assembly.

9. Mount Marker unit.

10. Connect filament leads to pins 2 & 7 of V-125 (above and to left on vertical panel).

11. Connect B+ lead to the outer terminal of R253 directly above R250.

12. Connect output lead to arm of S102-B.

13. Because of added capacitance of shielded cable capacitor C106 across L102 will have to be replaced with 200 μμf. capacitor (Item #61 of DAS spare parts, or item #88 of DAS-2 spare parts).

14. To the terminal of C106 that is common with pin 2 of V101-1 connect shielded cable.

15. This end of the shield should also be grounded.

E. Sweep Expansion

1. Facing the front of the indicator locate hole for toggle switch 3 1/2" from top of panel and 1 1/8" in from right hand side. (See Fig. 9).

2. Connect 2-connector shielded cable to terminals of switch.

3. Mount switch so that terminals of switch face cathode ray tube and ground shield. In this position, when switch is thrown to left, expanded sweeps will be obtained.

4. Facing the front of the indicator run the shielded cable back on the right hand side and through 3/4" grommet at the upper right hand corner of vertical panel. Lace cable in several places.

5. Turn indicator upside down and face the rear. Terminal Board 107 will be found under sweep adjustment potentiometers.

6. In order to work on Terminal Board 107 it is found advisable to remove panel containing the four potentiometers, and pull forward. There is no need to

disconnect any leads.

7. Locate R242 (180,000 ohm 1 watt resistor) and remove.

8. Replace with 100K 1 watt and 330K 1 watt in series, using spare lugs next to former position of R242.

9. Connect the two leads from the shielded cable across the 330K resistor. The shield can also be grounded on this end.

10. Locate R251 (3.6 meg 1/2 watt resistor) and replace with 6.8 megohms 1/2 watt resistor.

11. Locate C194 (1000 µµf. mica capacitor) and replace with 500 µµf. mica.

12. Remount potentiometer panel and replace Indicator in cabinet.

F. Smoother Fine Delay Action

1. For monitoring using the above expanded sweep it has been found that a smoother control of the Fine Delay is necessary. By replacing present control R-338 with composition potentiometer supplied with kit satisfactory results can be obtained. Remove Receiver and Power supply unit from cabinet.

2. Remove receiver for access to power supply and control panel.

3. Remove delay knobs and panel screws holding delay potentiometer bracket.

4. Replace R-338 with potentiometer supplied.

5. Reassemble above and replace unit in cabinet.

G. Alignment of Markers

1. Remove indicator from cabinet, and have front panel to the right. Turn on power being careful to keep away from high voltages.

2. To align the 2 µs markers adjust trimmer control to the left on coil assembly to obtain maximum amplitude. Adjust trimmer control to the right until every fifth 2 µs mark is centered on a 10 µs mark.

3. If, after the above adjustments have been made, it is desirable to increase the size of the 10 µs markers, locate C114 on Terminal Board 107 (see Step 6 under C) and parallel with 50 µµf capacitor (Item #41 of DAS spare parts or item #68 of DAS-2 spare parts).

H. Figures and Diagrams

Typical patterns obtained with the expanded sweep and with the marker generator are shown in Figures 1 to 6. Plates showing placement of the generator unit and switch are in Figures 7, 8 and 9. Circuit diagrams, Figs. 10 and 11, show details of generator and sweep modification.

I. Spare Parts Provided with Kit

2 Type 6SL7GT duo-triode tubes.

1 Navy type CFW-47516 i.f. transformer (Sickles Type 13279).

1 50 μμf. ±5%, mica capacitor, 500 volt.

1 200 μμf. ±10%, mica capacitor, 500 volt.

1 500μμf. ±5%, mica capacitor, 500 volt.

1 0.001 μf. ±10%, mica capacitor, 500 volt.

2 0.01 μf. ±10%, mica capacitor, 300 volt.

1 500,000 ohms., ±10%, 1/2 watt, carbon resistor.

1 2,000 ohms., ±10%, 1/2 watt, carbon resistor.

1 1,000 ohms., ±10%, 1/2 watt, carbon resistor.

1 50,000 ohms., ±10%, 1/2 watt, carbon resistor.

1 100,000 ohms., ±10%, 1 watt, carbon resistor.

1 330,000 ohms., ±10%, 1 watt, carbon resistor

1 6.8 megohms., ±10%, 1/2 watt, carbon resistor.

1 10,000 ohms., potentiometer, (Clarostat type 101-C/10M-S).

1 Toggle switch, bat handle, SPST, 13/32" shank, 3A 250V. (A.H. & H.)

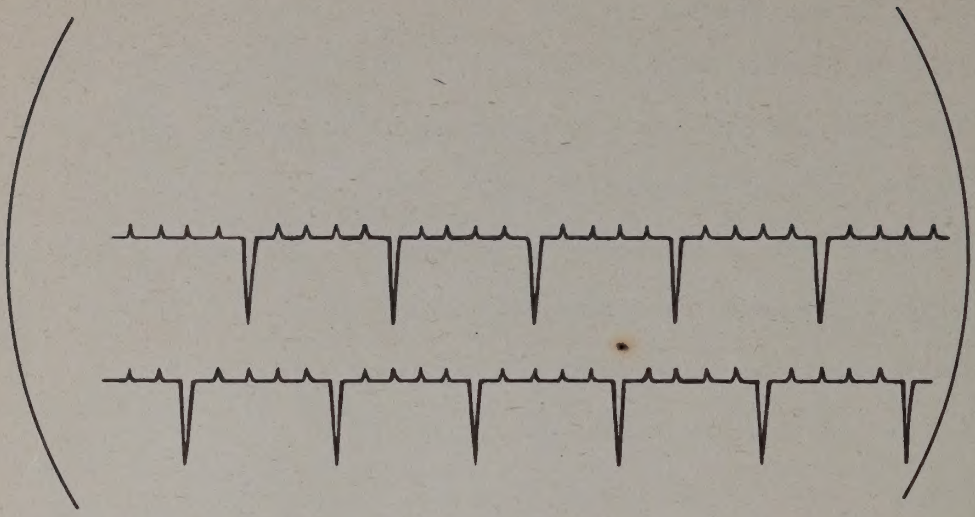

FIGURE 3 **SWEEP SPEED NO. 3 (EXPANDED SWEEP)**

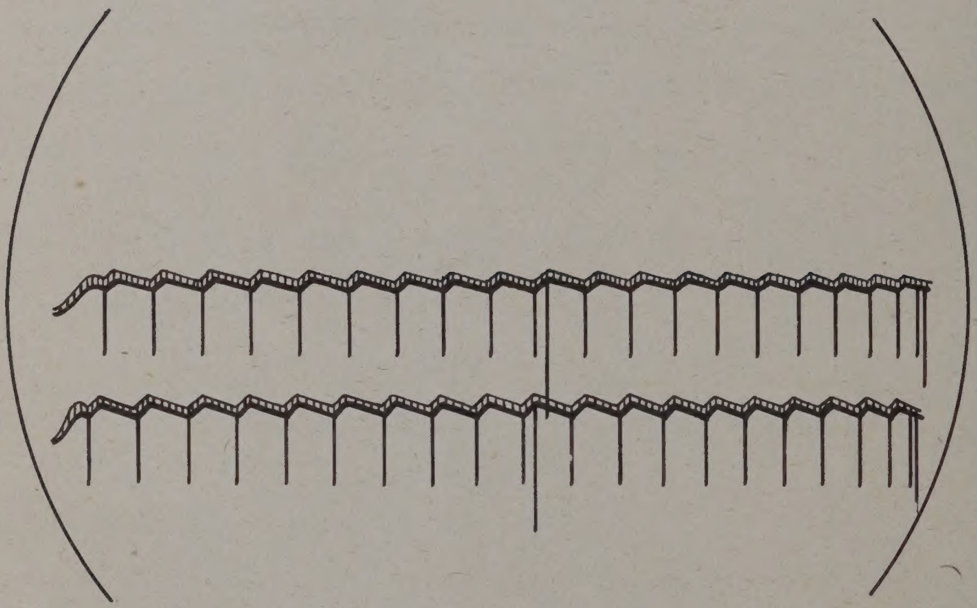

FIGURE 4 **SWEEP SPEED NO. 3 (NORMAL SWEEP)**

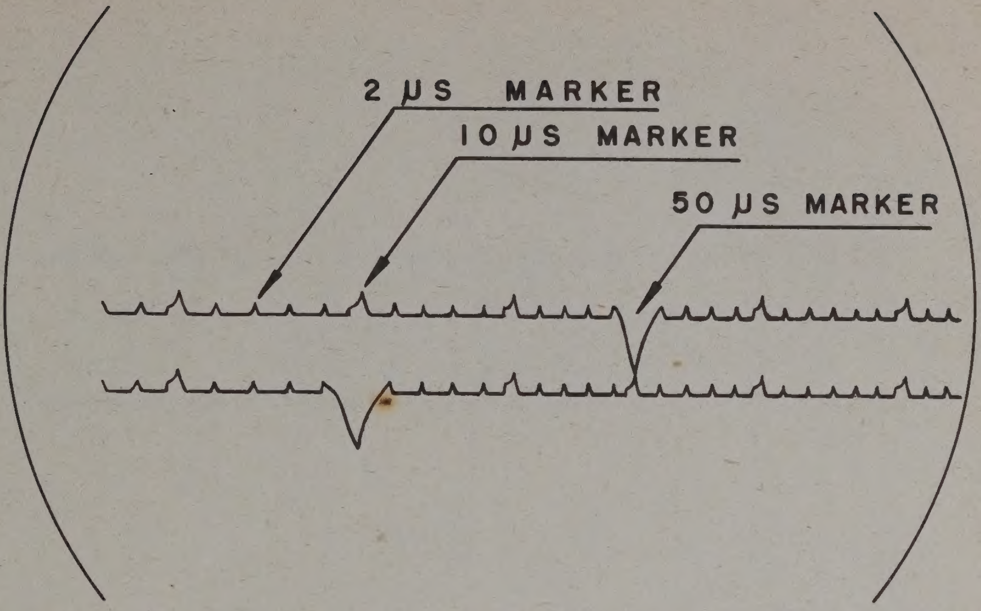
2 μS MARKER
10 μS MARKER
50 μS MARKER

FIGURE 1

SWEEP SPEED NO. 4
(EXPANDED SWEEP)

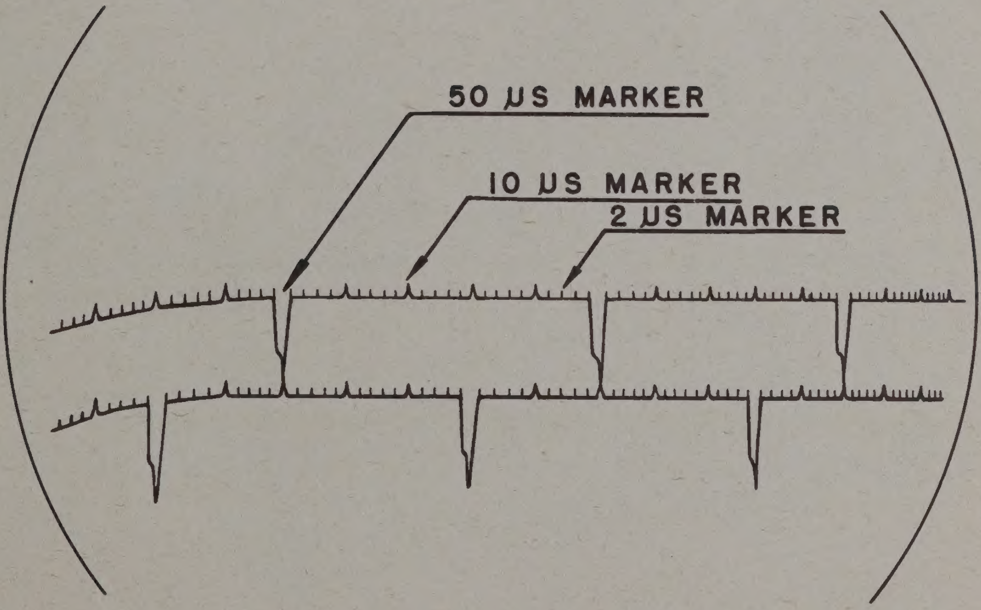
50 μS MARKER
10 μS MARKER
2 μS MARKER

FIGURE 2

SWEEP SPEED NO. 4
(NORMAL SWEEP)

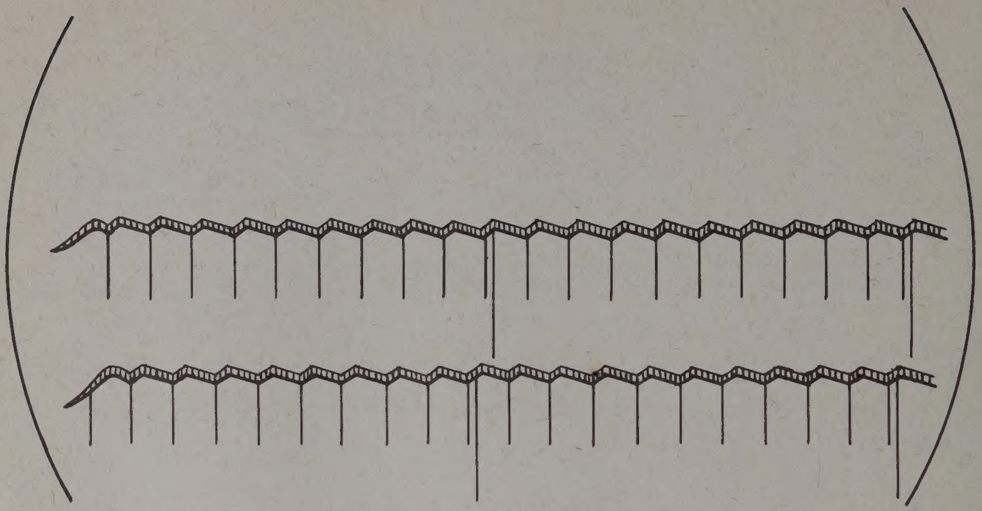

FIGURE 5 SWEEP SPEED NO. 2
(EXPANDED SWEEP)

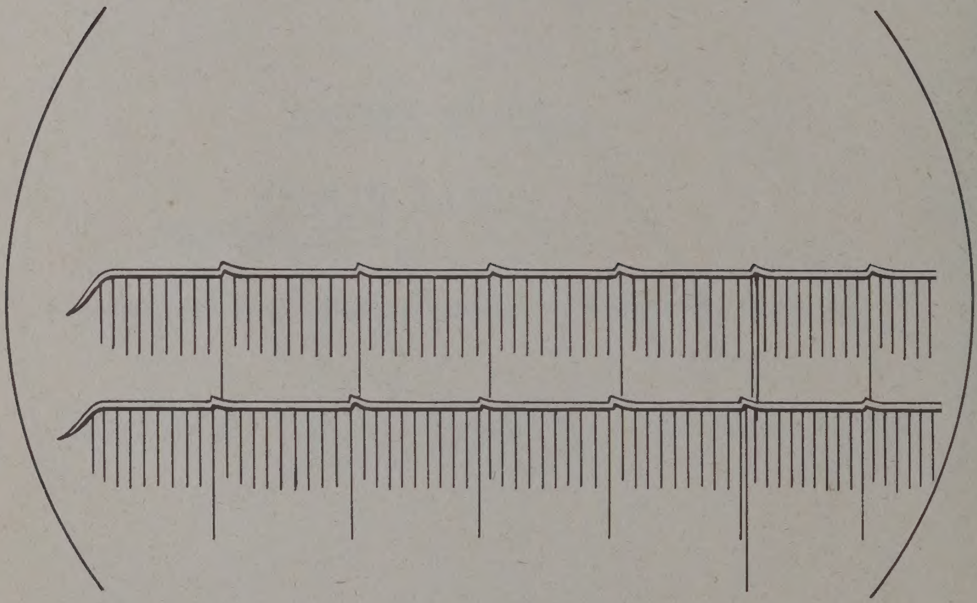

FIGURE 6 SWEEP SPEED NO. 2
(NORMAL SWEEP)

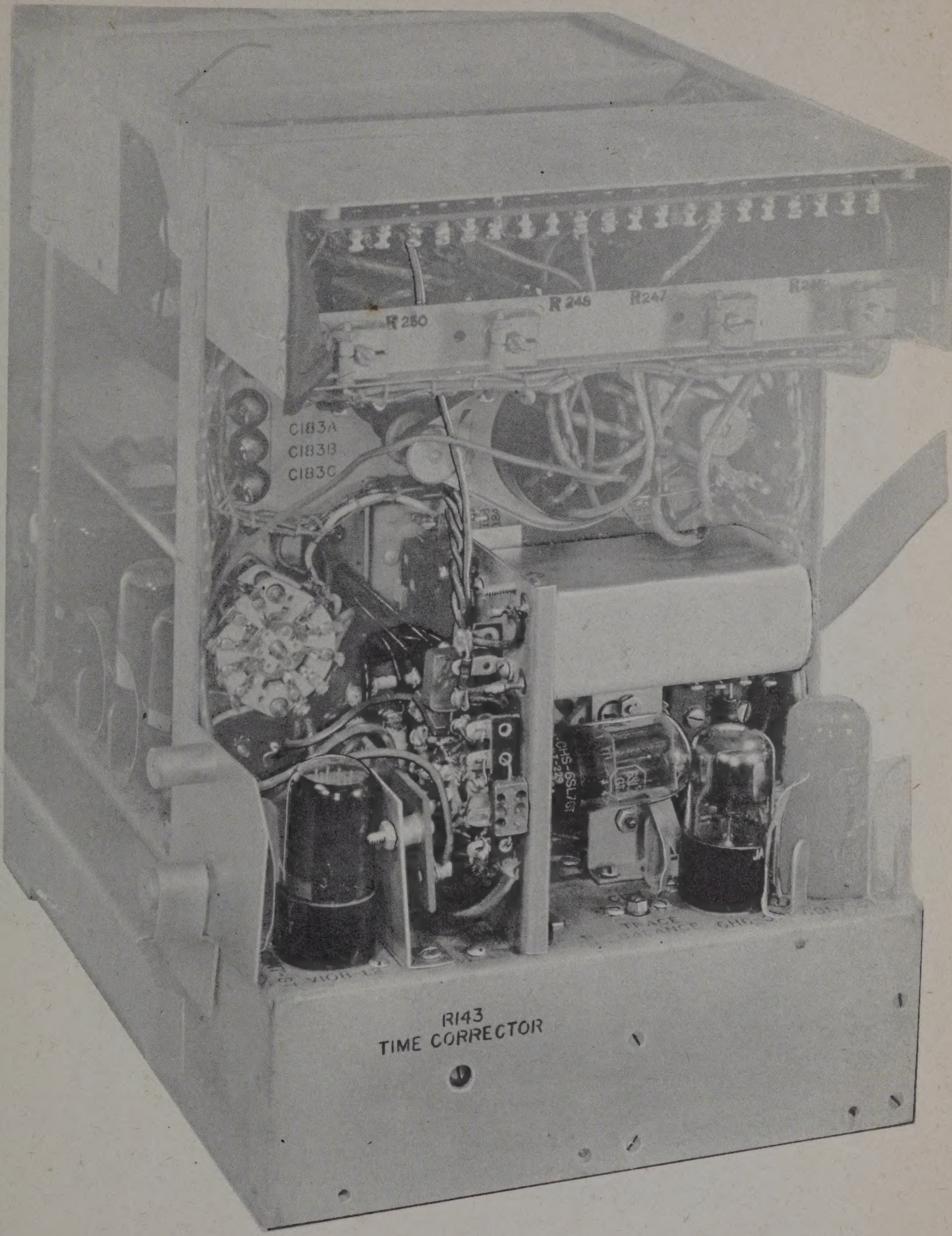
R250
R248
R247
C183A
C183B
C183C
R143
TIME CORRECTOR
TRACE BALANCE

FIG. 7.

REAR VIEW OF DAS INDICATOR
SHOWING LOCATION OF MARKER GENERATOR
AND ASSOCIATED WIRING

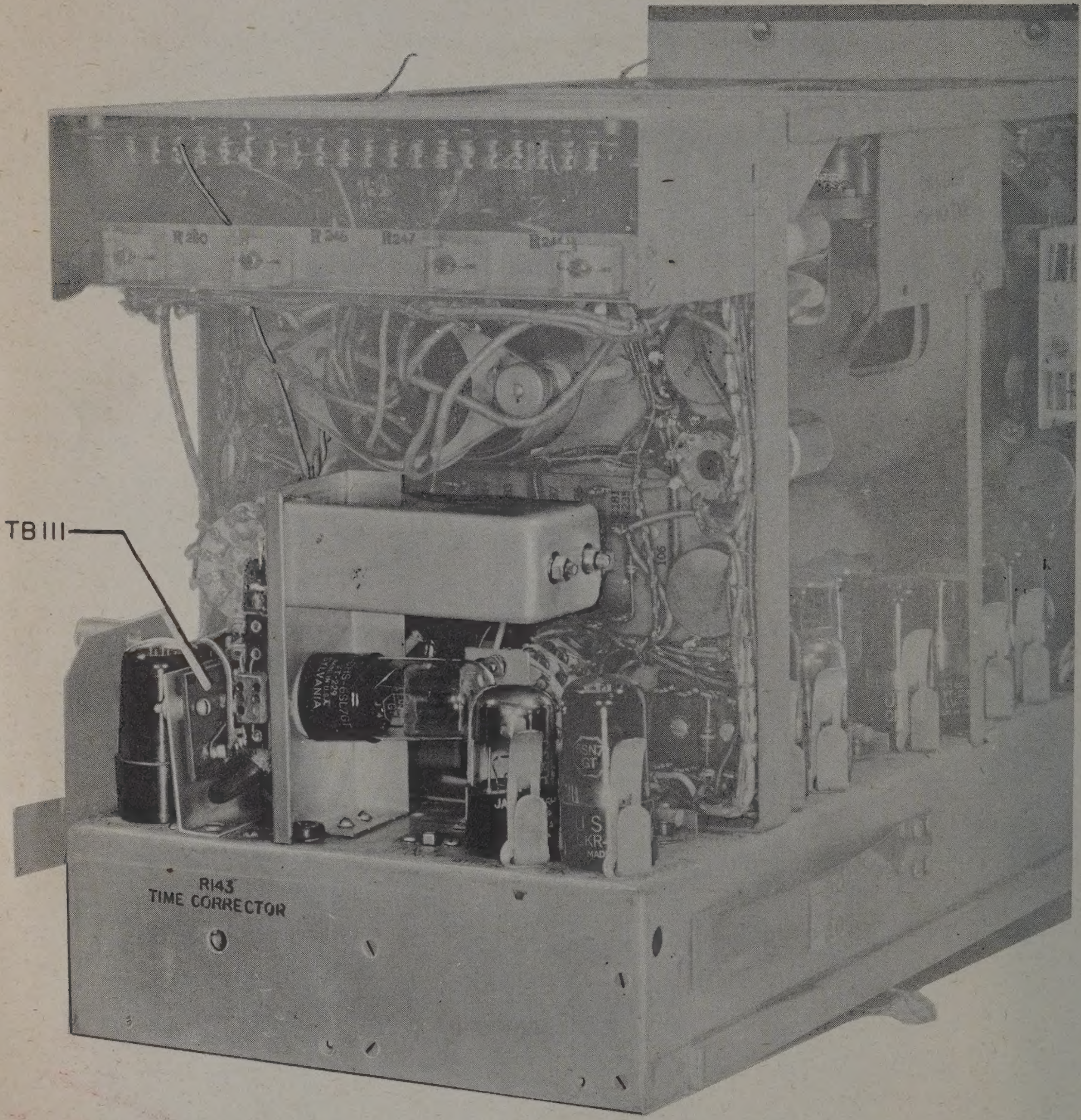
R280
R246
R247
R244
TB111
R143
TIME CORRECTOR

FIG. 8.

REAR OBLIQUE VIEW OF DAS INDICATOR
SHOWING METHOD OF PLACEMENT OF MARKER GENERATOR
AND SMALL BRACKET

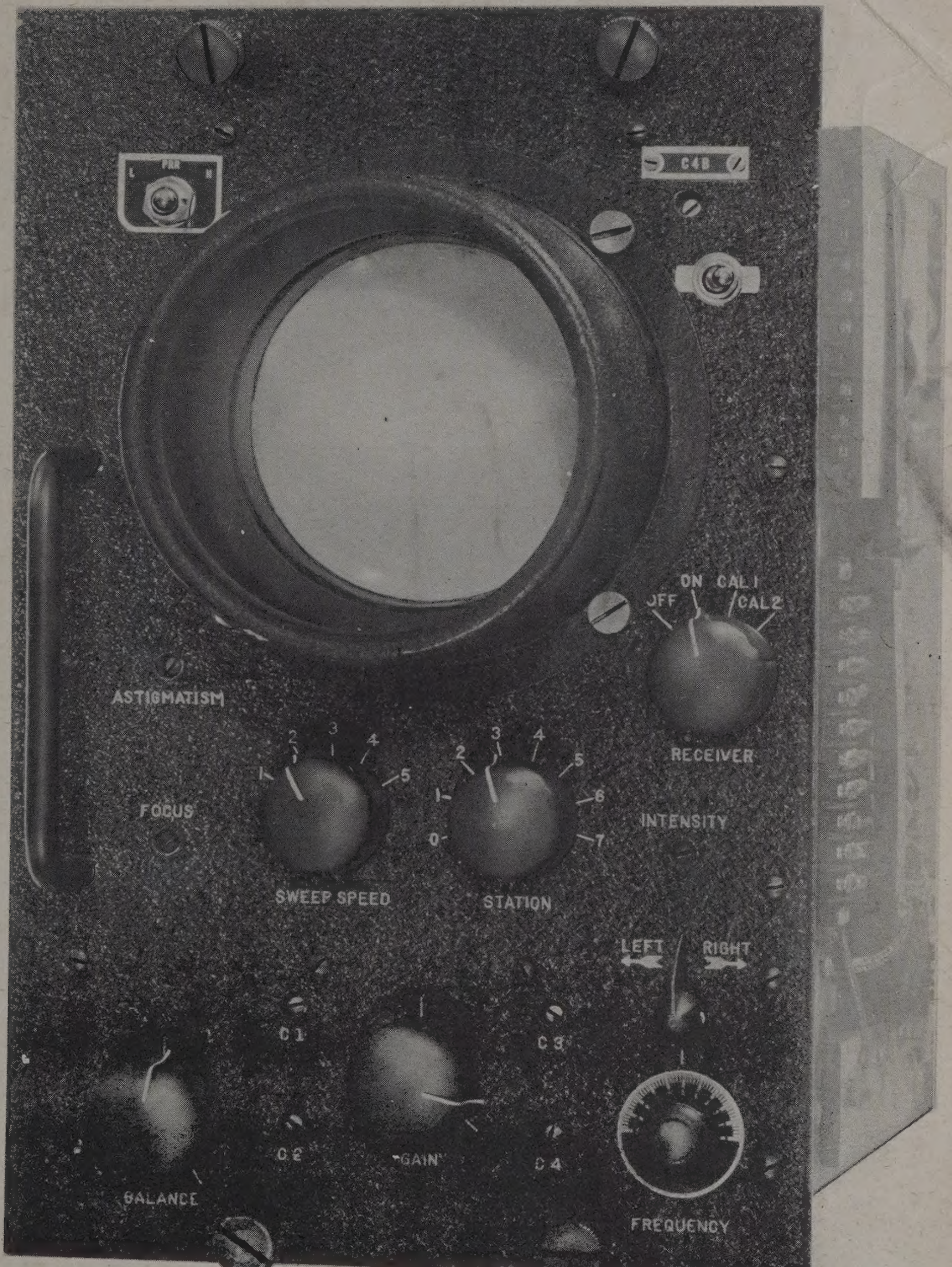
L
PRR
H
C4B
OFF
ON
CAL1
CAL2
RECEIVER
ASTIGMATISM
FOCUS
1
2
3
4
5
SWEEP SPEED
0
1
2
3
4
5
6
7
STATION
INTENSITY
LEFT
RIGHT
C1
C2
C3
C4
GAIN
BALANCE
FREQUENCY

FIG. 9.

FRONT VIEW DAS INDICATOR
SHOWING LOCATION FOR EXPANDED SWEEP SWITCH

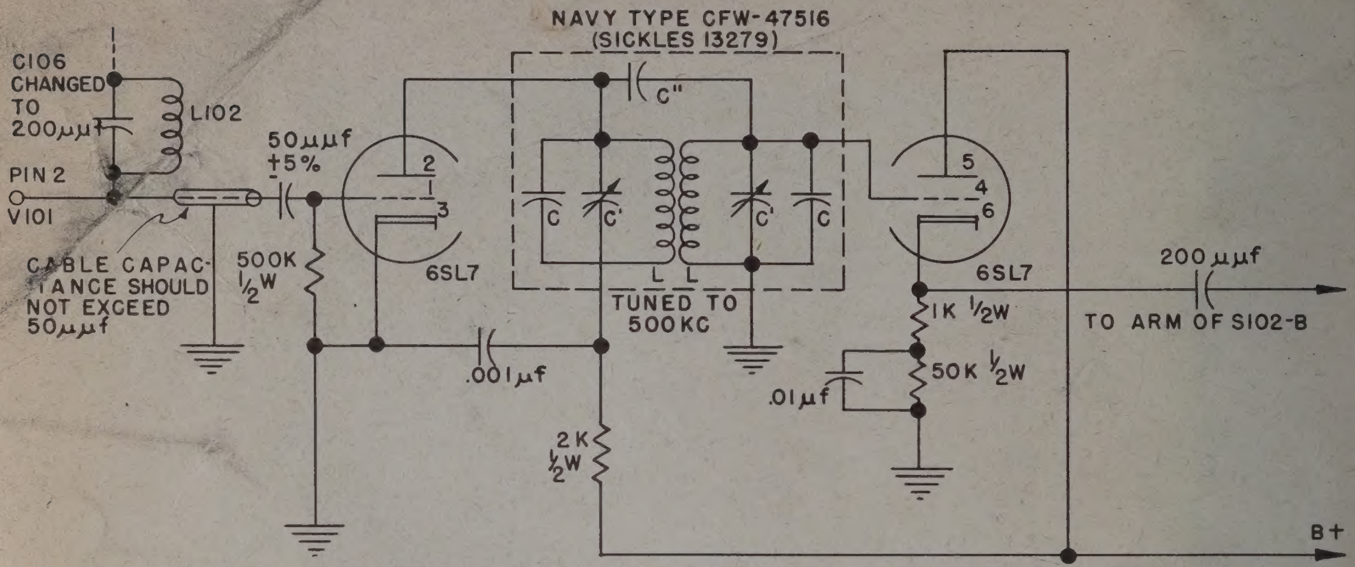
NAVY TYPE CFW-47516
(SICKLES 13279)
C106
CHANGED
TO
200μμf
L102
PIN 2
V101
50μμf
±5%
C"
2
1
3
C
C'
C'
C
5
4
6
CABLE CAPACITANCE SHOULD NOT EXCEED 50μμf
500K
½W
6SL7
L L
TUNED TO
500KC
6SL7
200μμf
1K ½W
TO ARM OF S102-B
.001μf
.01μf
50K ½W
2K
½W
B+

FIG. 10.
2 MICROSECOND MARKER CIRCUIT

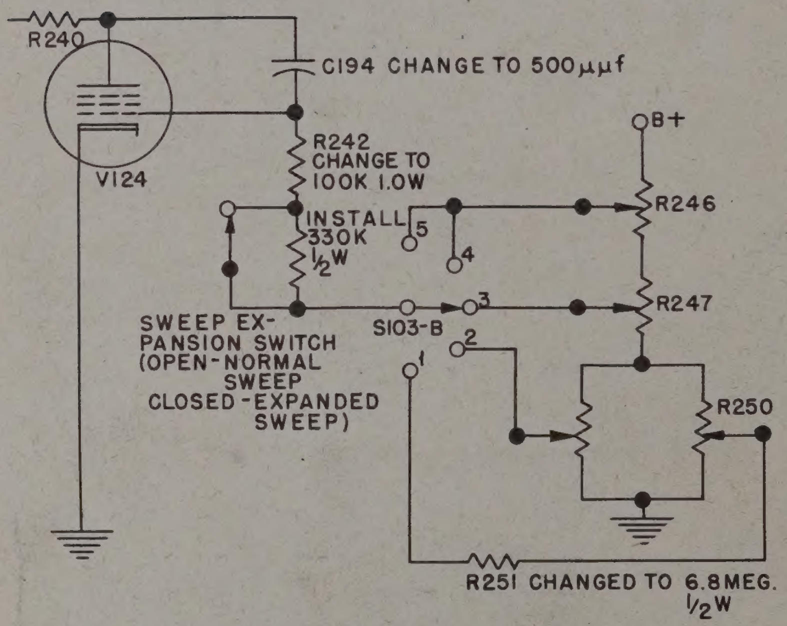
R240
C194 CHANGE TO 500μμf
B+
R242
CHANGE TO
100K 1.0W
V124
R246
INSTALL
330K
½W
5
4
3
R247
SWEEP EXPANSION SWITCH
(OPEN-NORMAL
SWEEP
CLOSED-EXPANDED
SWEEP)
S103-B
2
1
R250
R251 CHANGED TO 6.8MEG.
½W

FIG. 11.
FAST SWEEP MODIFICATION

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MODEL DAS

and

MODEL DAS-2

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Spare Schematic Diagrams of All Units are Included at the Rear of the Book.

REPLACEMENT MATERIAL

All requests or requisitions for replacement material should include complete descriptive data covering the part desired, in the following form:

1. Name of part desired.
2. Federal Stock number (if assigned).
3. Navy Type number (if assigned) (including *prefix* and *suffix* as applicable).
4. Commercial designation.
5. Model Designation (including *suffix*) of equipment in which used.
6. Navy Type designation (including *prefix* and *suffix* where applicable) of major unit in which part is used.
7. Contract, purchase order, requisition, etc., under which the equipment was procured.
8. Circuit symbol designation of part.
9. (a) Navy drawing and/or specification number (including part or group number).
   (b) Manufacturer's drawing or specification's number (include part or group number).
10. Rating or other descriptive data.

SAFETY AND WARNING NOTICES

ALTHOUGH INTERLOCK PROTECTION IS NOT PROVIDED, THE OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES (2200 VOLTS) WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT WITH HIGH VOLTAGE SUPPLY ON; ALWAYS REMOVE POWER CONNECTOR. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES ALWAYS REMOVE POWER, DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM. EQUIPMENT SPACE HEATERS ARE ON WHEN THE POWER SWITCH IS IN THE OFF POSITION.

Since the use of high voltages (2200 volts) which are dangerous to human life is necessary to the successful operation of the equipment covered by these instructions, certain reasonable precautionary measures must be carefully observed by operating personnel during the adjustment and operation of the equipment.

It should be borne in mind that interlocks are not provided and therefore side, back or top screens, if removed, allow access to circuits carrying voltages dangerous to human life.

KEEP AWAY FROM LIVE CIRCUITS. Under no circumstances should any person other than authorized maintenance personnel be permitted to reach within or in any manner gain access to the enclosure with power supply line switches to the equipment closed; or to approach or handle any portion of the equipment which is supplied with power, or to connect any apparatus external to the enclosure to circuits within the equipment or to apply voltages to the equipment for testing purposes while any portion of the shielding or enclosure is removed or open. Wherever feasible in testing circuits, maintenance personnel should check for continuity and resistance rather than directly checking voltage at various points.

DON'T SERVICE OR ADJUST ALONE. Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

THE ATTENTION OF OFFICERS AND OPERATING PERSONNEL IS DIRECTED TO CHAPTER 67 OF BUREAU OF SHIPS MANUAL OR SUPERSEDING INSTRUCTIONS ON THE SUBJECT OF "RADIO-SAFETY PRECAUTIONS TO BE OBSERVED".

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

GUARANTEE

The equipment including all parts and spare parts, except vacuum tubes, rubber and material normally consumed in operation is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f.o.b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the contractor is notified thereof in writing within a reasonable time, and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment including all parts and spare parts, as defined above, is of the contractor's design or is of a design selected by the contractor it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten per cent (10%) or more of any such item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred per cent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the World or under such conditions as to preclude the return of the defective item for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for effecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any such defects and any items repaired or replaced by the contractor will be guaranteed anew under this provision.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its service life, shall be made to the Bureau of Ships in accordance with current Instructions. The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures, see Chapter 67 of the "Bureau of Ships Manual", or superseding instructions.

INSTALLATION RECORD

Contract Number: NXss-26190; Date of Contract: Mar. 20, 1943
NXsr-35364; Aug. 3, 1943

Serial Number of Equipment

Date of Acceptance by the Navy

Date of Delivery to Contract Destination

Date of Completion of Installation

Date Placed in Service

Blank spaces on this page shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date of acceptance plate located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

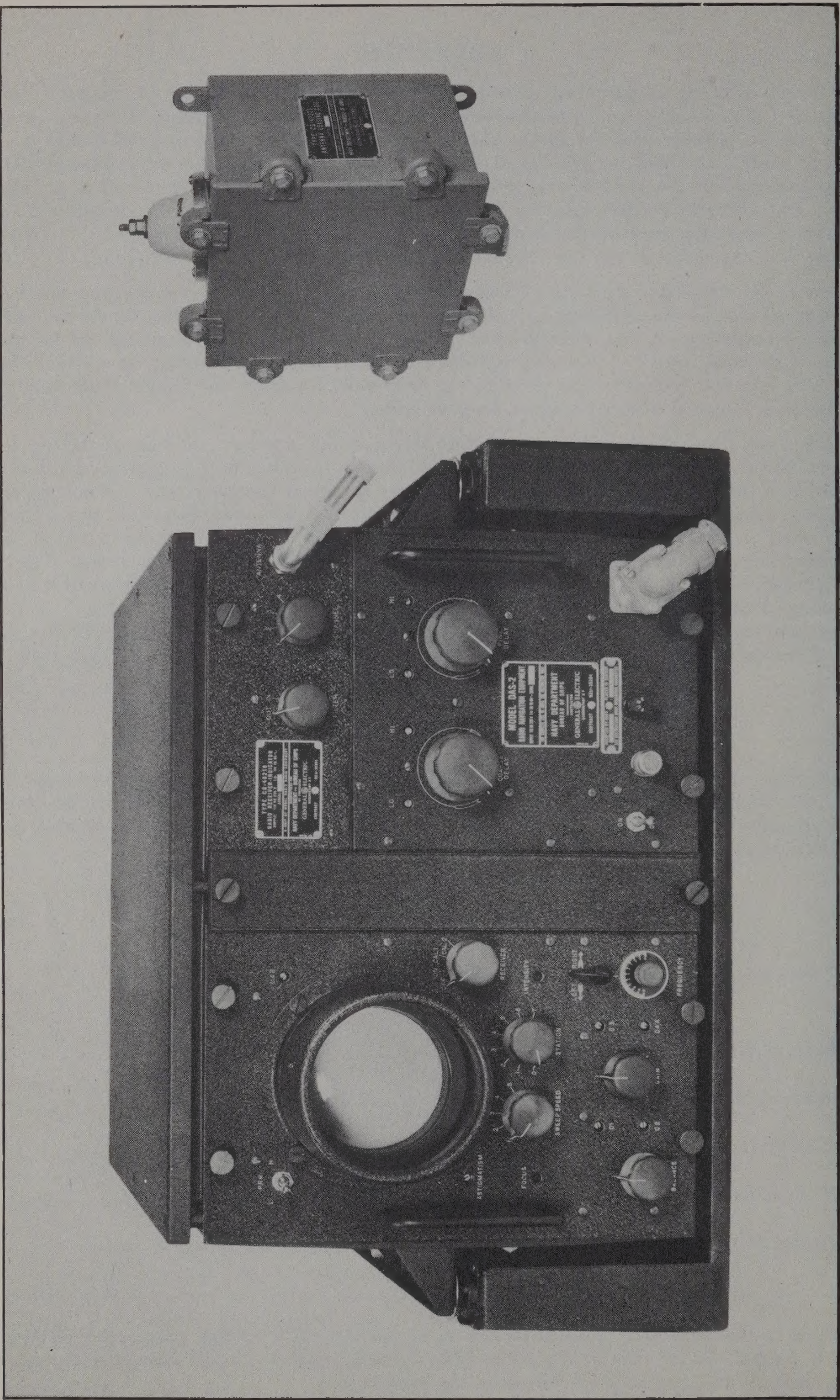

MODEL DAS-2
NAVY DEPARTMENT
GENERAL ELECTRIC

Figure 1-1—Loran Radio Navigation Equipment, Navy Model DAS-2, Components

I. GENERAL DESCRIPTION

1. QUICK REFERENCE DATA.

a. NOMENCLATURE	Model DAS	Model DAS-2
b. CONTRACT NO.	NXss-26190	NXsr-35364
c. CONTRACT DATE	Mar. 20, 1943	Aug. 3, 1943

d. CONTRACTOR—General Electric Co.

e. COGNIZANT NAVAL INSPECTOR—Resident Inspector of Naval Material, Bridgeport, Conn.

f. RECEIVER FRENQUENCY RANGE—1.7 mc to 2.075 mc and 9.9 mc to 12.1 mc.

g. CHARACTERISTICS OF POWER SUPPLY REQUIRED FOR OPERATION—

(1) 115 or 230 volts, A-C, single phase, 50 to 60 cycles

(2) Equipment Power Factor —— .96

(3) Current requirements.

	115 v.	*230 v.*
Stand-by Heating	.334 amp.	.167 amp.
Normal Operation	2.50 amps.	1.25 amps.
Maximum	2.75 amps.	1.38 amps.

h. CRYSTAL COMPLEMENT—
Indicator Unit Crystal—100 kc (crystal supplied)
Receiver Unit Crystal—None required

i. TOTAL PACKAGES PER SHIPMENT—TWO
One for Operating Equipment,
One for Operating Spare Parts

j. VACUUM TUBE COMPLEMENT.

Number	Type	Description
2	2X2	Half Wave Rectifier
1	5CP1	Cathode Ray Tube
1	5U4G	Full Wave Rectifier
1	6AC7	High Gain Pentode
1	6AG7	High Gain Pentode
7	6H6GT	Duo Diodes
3	6H6	Duo Diode
2	6J5GT	Triodes
1	6SA7	Pentagrid Converter
2	*6SG7	High Gain Pentodes
2	†6SK7	High Gain Pentodes
7	6SL7GT	Duo Triodes
10	6SN7GT	Duo Triodes
2	6Y6G	Beam Power Amplifiers
1	VR150	Voltage Regulator

* The 6SG7 tubes were replaced by 6SK7 tubes in Change No. 5 (See page 1-3 for serial numbers of units affected by Change No. 5).

† One 6SK7 tube was changed to one 6SJ7 in all Model DAS-2 units, and in Change No. 3. (See page 1-3 for serial numbers of units affected by Change No. 3.)

k. TOTAL CUBICAL CONTENTS, PACKED FOR SHIPMENT—
Equipment—16.5 cu. ft.
Spare Parts—3.9 cu. ft.

l. TOTAL WEIGHT, PACKED FOR SHIPMENT—
Equipment—308 lbs.
Spare Parts—125 lbs

2. DESCRIPTION OF LORAN SYSTEM.

The LORAN system is a navigational system for determining positions by means of radio. The term is derived from the initial letters of the words "*LO*ng *RA*nge *N*avigation" and consequently implies that the distances involved are greater than those obtained by the familiar radio direction finding methods. Ordinarily over sea water, ranges may be expected of from 500 to 750 nautical miles during the daytime and up to 1400 nautical miles at night. The extended night time range is obtained by the use of "sky wave" transmission, and results obtained, while good, are not as reliable as those obtained with ground wave transmission.

The principle of operation is based on the difference in travel time (in millionths of a second) to the point of observation, of radio signals from two transmitting stations spaced several hundred miles apart. Assume that pulse signals are transmitted at exactly the same instant from the two transmitting stations. It is evident that along the perpendicular bisector of the base line connecting the two stations, the two pulse signals will arrive at exactly the same time since any point along this bisector is equally distant from the two transmitters. For observation points on either side of the bisector, the signal from the nearer station arrives ahead of the other and the loci for observation points of given time differences are represented by hyperbolas with the two transmitting stations at the two foci. The hyperbolas on the side of the bisector toward transmitting station, let us say, "A" correspond to pulses from "A" arriving first. On the other side of the bisector is a similar set of hyperbolas corresponding to pulses from transmitting station "B" arriving first.

Since the pulses from the two transmitting stations are essentially identical in shape, it is not possible to tell whether the pulse which arrives first originated at station "A" or station "B". This results in an ambiguity as to which of two hyperbolas—one on each side of the bisector—is the true line of position. To overcome this ambiguity and at the same time simplify the measurement method, the pulses from the two transmitting stations are not transmitted simultaneously but those from one station are delayed a finite amount in order that the pulse from that station will always arrive last. The amount of this delay needs to be at least equal to slightly more than the travel time of the radio signal between the two transmitting stations. Actually it is much

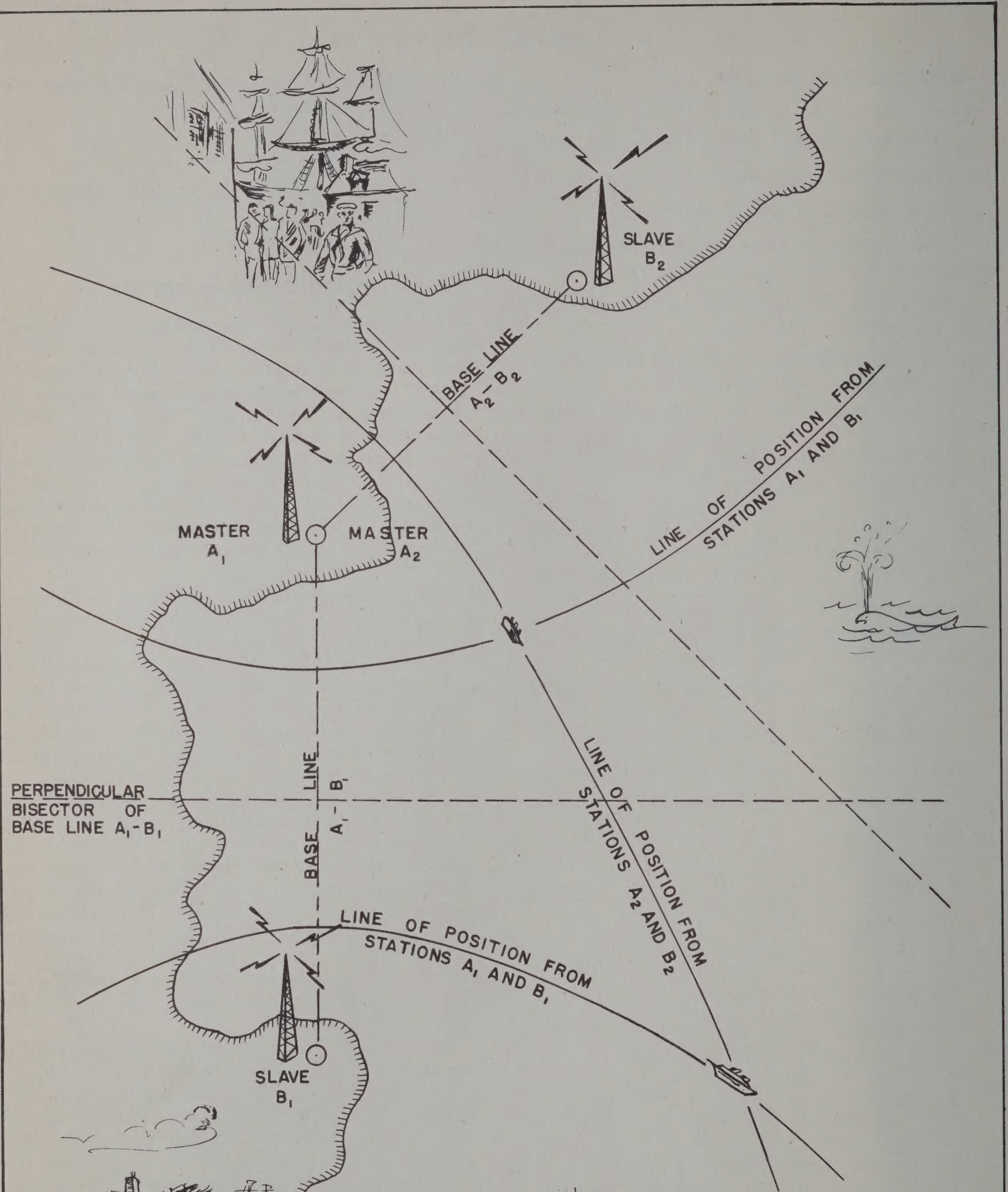

SLAVE
B₂
BASE LINE
A₂ - B₂
LINE OF POSITION FROM
STATIONS A₁ AND B₁
MASTER
A₁
MASTER
A₂
BASE LINE
A₁ - B₁
PERPENDICULAR
BISECTOR OF
BASE LINE A₁-B₁
LINE OF POSITION FROM
STATIONS A₂ AND B₂
LINE OF POSITION FROM
STATIONS A₁ AND B₁
SLAVE
B₁

Figure 1-2—Line Sketch of Loran Principles

more than that. However, as long as it is always a definite amount, proper allowances can always be made.

The transmitted signals are not isolated pulses, first from one transmitter and then the other, but a series of carefully timed pulses from each which are properly interspaced. The time interval between each station's pulses is constant for a given pair of stations but differs for various pairs as a means of identification and to avoid interference of other Loran signals. These recurrence periods vary from about 30,000 microseconds to 40,000 microseconds.

It was previously stated that the interval between the pulses from one transmitting station and the corresponding ones from the second station must be carefully timed with respect to each other. Any adjustment required should be made at only one station to avoid confusion. This station is termed a "slave" station, whereas the other is the "master" station.

It is evident that in addition to the radio transmitter, power supply, antennas and accessory equipment usually found in a radio transmitting station, there must be additional equipment for timing the pulses accurately and, at the slave station, equipment for adjusting the interval between the master and slave pulses to within a microsecond of the pre-determined delay.

On the ship or aircraft, a combined radio *Receiver* and *Indicator* is used which is capable of determining the differences in times of arrival to within a microsecond. This measurement determines the line of position as indicated on carefully prepared charts (or tables). Similar measurements made on a second pair of LORAN stations provides a second line of position. Intersection of two or more lines of position determines a "fix" in the conventional manner.

This book covers the installation, operation, circuit theory and maintenance of the Model DAS and Model DAS-2 Receiver-Indicator Units only. For a more detailed explanation of the basic principles of the Loran System, see the LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278), published by the Bureau of Ships.

3. LORAN RECEIVER-INDICATOR.

Model DAS and Model DAS-2 are the names given to Loran Receiver-Indicator Units built by the General Electric Co. These units receive the pulses from the transmitters and measure the time interval between them, placing this information on an oscilloscope screen where it may be observed and recorded by an operator.

The units are designed specifically for shipboard installation, and will withstand the weather conditions and shocks to be encountered at sea. A single cabinet of welded steel construction, drip-proof, and suspended on rubber mountings in a cradle, contains three units, the Radio Receiver, the Time Measuring Indicator, and the Power Supply, as shown in Fig. 7-1. The cabinet is designed for interior mounting. The only part of the equipment not in the cabinet is a loading-coil for the antenna, which is enclosed in a small weatherproof box, Fig. 1-8, suitable for outside mounting. A single length of wire, 45 to 125 ft. long, will serve as an antenna.

Since the Navigator will use the information obtained by the Receiver-Indicator, it should be located in the chartroom whenever possible. In cases where the space is too limited, however, a satisfactory location may be found either close to the chartroom, or where the information may be easily and quickly communicated to the Navigator. A mounting space of about 1½ x 2½ x 2 feet, at eye level, is required.

Only one man is needed to operate the equipment, usually the Navigator or the Quartermaster. He does not need any previous knowledge or understanding of radio, but special training in LORAN operation is highly desirable.

The accuracy of a "fix" obtained with LORAN equipment is much greater than one obtained by any other method under similar conditions. A detailed discussion of the accuracy is contained in the "LORAN HANDBOOK FOR SHIPBOARD OPERATORS," and it will be sufficient to mention here that it varies greatly, and depends upon a number of factors. *Accuracy is not affected by the location of antenna or Receiver-Indicator aboard ship.*

4. EQUIPMENT MODIFICATIONS DURING PRODUCTION.

In addition to the changes incorporated in the equipment during the transition from the Model DAS to the Model DAS-2, there have been a number of other modifications. Since these changes were made after the units were in production, in some equipments they will appear and in others they will not. The first thing to do, therefore, in becoming familiar with the equipment, is check its serial number against the list below and see which changes have been incorporated in it. Any changes which have not been made should be corrected at once in the field. Kits of parts and instructions for making the changes are available to all equipments requiring them. If the kits have not been received and installed already, inquire about them from the installing activity or the Bureau of Ships (Code 981).

Serial No.	Equipment Changes Made at Factory	Kits Required
1 through 5	None	#1,#2,#3
6 through 106	#1	#2,#3
107 through 200	#1,#2	#2,#3
201 through 375	#1,#2,#3	#3
376 through 404	#1,#2,#3,#4	#3
405 and 406	#1,#2,#3,#4,#5	#3
407	#1,#2,#3,#4	#3
408 through 580	#1,#2,#3,#4,#5	#3
581 through 770	#1,#2,#3,#4,#5,#6	None
771 and above	#1,#2,#3,#4,#5,#6,#7	None

Kits #1 and #2 cover the changes required to make the DAS like the first DAS-2 equipments and if Kit #2 has been installed the model designation will have the suffix "a" and the Type designation the suffix "A" stamped on the nameplate.

Equipment Change No.	Kit No. Required	Change Description
1.	1	Move seven STATION SELECTOR air trimmers from the rear deck of the Indicator Unit, to the front of the vertical chassis.
2.	3	Change the Time Corrector Circuit by removing two grid resistors.
3.	2	Improve the focus of the Cathode Ray Tube and add a PRR switch and circuits to give the basic pulse recurrence rate, H (33⅓ per second) in addition to the basic pulse recurrence rate L (25 per second).
4.	3	Remove the filament ground connection in the Indicator Unit.
5.	3	Improve the Balance Gain Control so that signals with with a greater difference in magnitude may be balanced.
6.	3	Replace Main Gain and Fine Delay control potentiometers.
7.	None	Add a resistor, R285 in the cathode circuit of the Fourth Counter.

One additional change will be made to the equipments in the near future. At present all equipment receivers are supplied with four CHANNELS covering two frequency ranges, two CHANNELS for each range. A kit containing receiver coils is being prepared for each unit, and after the coils have been installed all four CHANNELS will cover the lower frequency range only. The two higher frequency channels have never been used.

After the Receiver channels have been changed, the DAS model designation will have the suffix "b" and the type designation the suffix "B", while the DAS-2 will have the model designation suffix "a" and type designation "B". In addition, the DAS-2 receiver type number will have the suffix "A".

Instructions for making all equipment modifications may be found in the Maintenance section of this book. Model and type nameplate markings are given in the following table.

Contract NXss-26190

Model	DAS	DAS-a	DAS-b
Receiver-Indicator Type Number	CG-46210	CG-46210A	CG-46210B
Antenna Loading Coil Type Number	CG-47335	CG-47335	CG-47335
		MODEL DAS to which a PRR switch has been added.	MODEL DAS-a in which the high frequency channels have been changed to the low frequency.

Contract NXsr-35364

Model	DAS-2	DAS-2b
Receiver-Indicator, Type Number	CG-46210A	CG-46210B
Indicator Type	CG-55147	CG-55147
Receiver Type	CG-46244	CG-46244A
Power Supply Type	CG-20288	CG-20288
Mounting Rack Type	CALM 10323	CALM 10323
Antenna Loading Coil Type Number	CG-47335	CG-47335
		MODEL DAS-2 in which the high frequency channels have been changed to the low frequency.

5. DESCRIPTION OF EQUIPMENT.

a. EQUIPMENT SUPPLIED.

Quantity	Name of Unit	Navy Type Designation	Overall dimensions (*A:* Crated—*B:* Uncrated) Height	Width	Depth	Volume *A:* Crated *B:* Uncrated	Weight *A:* Crated *B:* Uncrated
1	Receiver-Indicator (including Power supply and full complement of vacuum tubes) For Component Parts, see page 1-7)	CG-46210	*A:* 33″ *B:* 17⅞″	 34″ 28⅛″	 27″ 22⅝″	*A:* 16.5 cu. ft. *B:* 6.6 cu. ft.	*A:* 308 lbs. *B:* 210 lbs.
1	Antenna Loading Coil	CG-47335	*A:* Included in Crate with Receiver-Indicator Unit *B:* 11⅛″	 7″	 5½″	*A:* *B:* .25 cu. ft.	*A:* *B:* 8 lbs.
1 set	Operating Spare Parts	See Spare Parts Lists Page 6-1.	*A:* 15¾″ *B:* 15″	 25⅝″ 24″	 16⅝″ 15″	*A:* 3.9 cu. ft. *B:* 3.12 cu. ft.	*A:* 125 lbs. *B:* 110 lbs.

b. EQUIPMENT REQUIRED, BUT NOT SUPPLIED.

Quantity	Name of Unit	Required Characteristics
12	Mounting Bolts	⅜ inch, No 20. Long enough to penetrate the Chart-room bulkhead, plus 1 inch
40′ to 120′	Antenna Wire	No. 12 stranded Standard Antenna Wire, Silicon Bronze
2	Strain Insulators	six inch Strain insulators, similar to Navy Type 61014
1 spool	Coaxial Cable	RG 10/u (CASSF-50-1A)
1 spool	Power Cable	Two Conductor, like Navy Type MCOS-2

c. PUBLICATIONS REQUIRED BUT NOT SUPPLIED WITH EQUIPMENT.

(1) LORAN TABLES OR CHARTS (PUBLISHED BY HYDROGRAPHIC OFFICE).—Necessary to get lines of a position from the time differences measured by the Model DAS and Model DAS-2 equipments. Consult installing activity or Hydrographic Office.

(2) LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278) (PUBLISHED BY BUREAU OF SHIPS).—Describes Loran System in great detail, and explains practical navigational use of equipment, including interpretation of signal patterns appearing on cathode ray screen of Model DAS and DAS-2 equipments. Consult installing activity, Registered Publications Issuing Offices, or Bureau of Ships (Code 993).

d. COMPONENT UNITS—DESCRIPTON.

(1) RECEIVER-INDICATOR UNIT CABINET.—The cabinet is designed for horiontal mounting with the two removable chassis slid into place side-by-side, from the front. Seven rubber shock mounts support the cabinet on a cradle in such a manner that they receive nearly equal loads. The chassis are held securely in place by captive thumbscrews spaced around the peri-

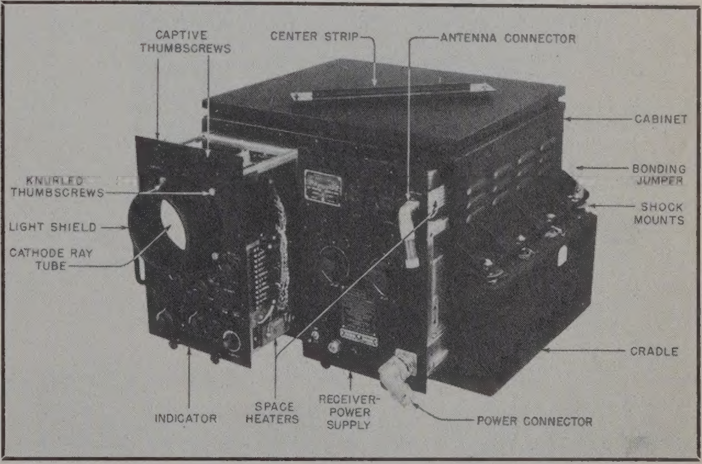


Figure 1-3—Model DAS Receiver-Indicator Unit, Navy Type CG-46210, Inspection Position

phery of the panels, and may be withdrawn separately. A narrow strip, also held in place by thumbscrews, covers the space between the front panels of the two units. (See Fig. 1-3.) A safety catch is provided on both chassis to stop them when they are withdrawn about two thirds of the way from the cabinet.

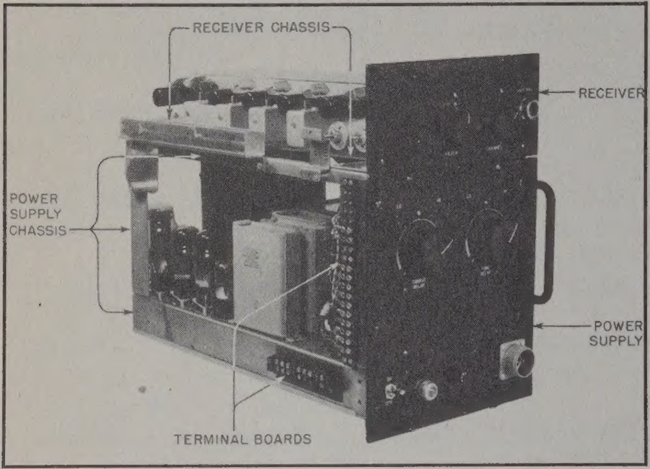

RECEIVER CHASSIS
RECEIVER
POWER SUPPLY CHASSIS
POWER SUPPLY
TERMINAL BOARDS

Figure 1-4—Receiver and Power Supply Units, Chassis Removed from Cabinet

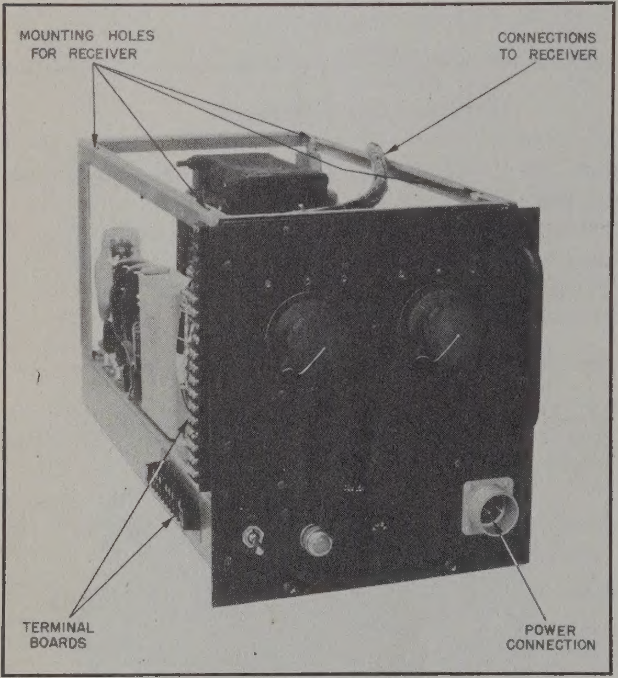

MOUNTING HOLES FOR RECEIVER
CONNECTIONS TO RECEIVER
TERMINAL BOARDS
POWER CONNECTION

Figure 1-5—Power Supply Unit with Receiver Unit Removed

(2) POWER SUPPLY UNIT.—The Power Supply and Receiver Units are on separate chassis with separate front panels, but the two are held together by four screws to form a single assembly, as shown in Fig. 1-4. The Power Supply Unit is the lower chassis of the two (Fig. 1-5) and is complete with transformers, rectifiers, filters and voltage regulators. Power is brought into the unit through a two conductor A-N receptacle mounted on the front panel, and is supplied to the other units from terminal boards mounted on the side of the Power Unit chassis.

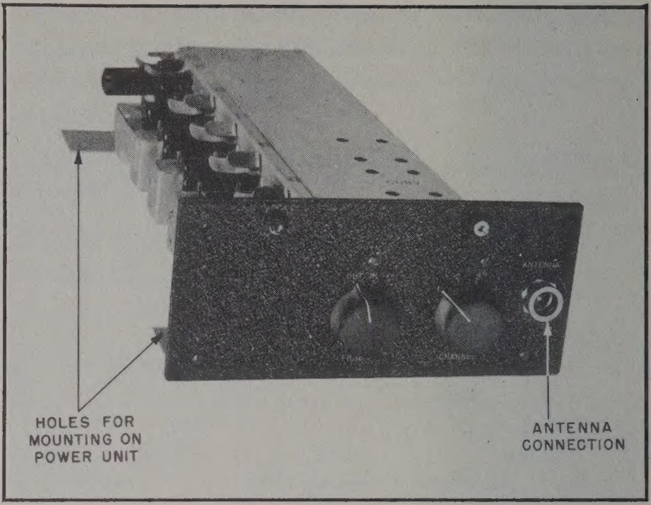

HOLES FOR MOUNTING ON POWER UNIT
ANTENNA CONNECTION

Figure 1-6—Radio Receiver Unit, Demounted from Power Supply Unit

(3) RECEIVER UNIT.—The Radio Receiver Unit (Fig. 1-6) is mounted over the Power Supply Unit, and may easily be removed for repairs. All adjustments, however, are made accessible by partially withdrawing the Receiver-Power Supply assembly from the cabinet. A metal shield covers most of the circuits, but not the tubes. The antenna connection is made through a Navy Type 49120 receptacle, mounted in the front panel.

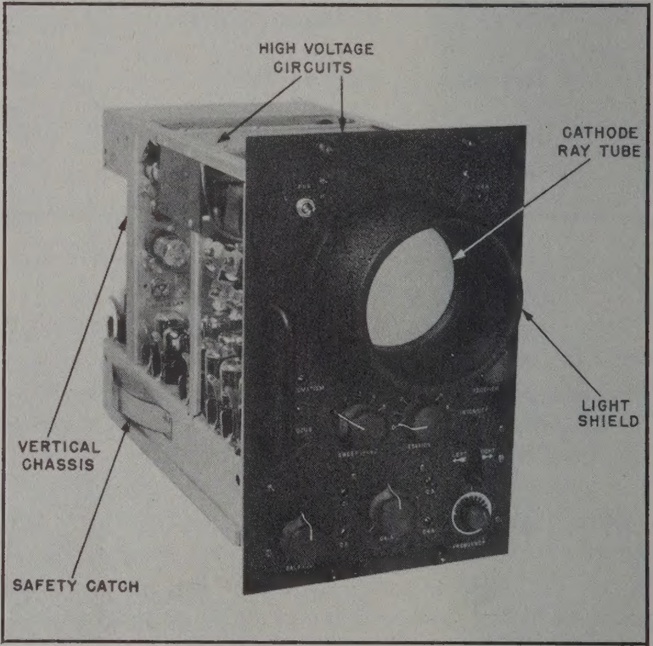

HIGH VOLTAGE CIRCUITS
CATHODE RAY TUBE
LIGHT SHIELD
VERTICAL CHASSIS
SAFETY CATCH

Figure 1-7—Indicator Unit, Chassis Removed from Cabinet

(4) INDICATOR UNIT.—The Indicator Unit, Fig. 1-7, is comprised of a horizontal chassis, with a vertical sub-chassis rising from it about three-fourths of the way to the rear. The cathode ray tube socket is mounted in the vertical chassis, and the tube extends

through the front panel. Maintenance adjustments are mounted on the two chassis, and all operational adjustments are provided with front panel controls. A light shield and safety glass cover protects the screen of the cathode ray tube, and a cone-shaped, close fitting shield protects its walls. All high voltage (over 500 volts) circuits are mounted above the chassis and protected by insulating shields.

WARNING

The vacuum tube mounted on the top panel is operated at 1600 volts. Do not use a metal tube in this socket (X122) as the shell will be at 1600 volts.

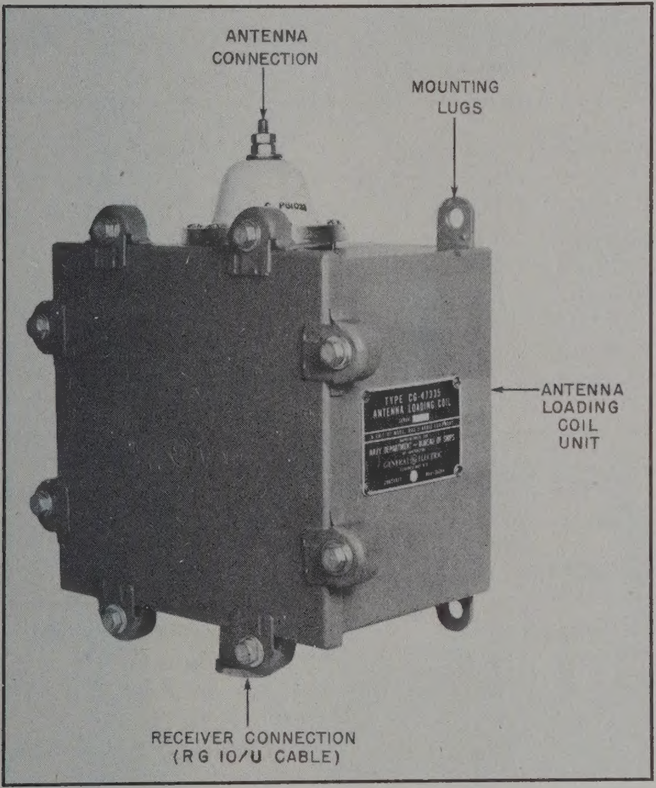


Figure 1-8—Antenna Loading-Coil Unit, Navy Type CG-47335

(5) ANTENNA LOADING-COIL.—The Antenna Loading-Coil Unit, Fig. 1-8, is sealed in a watertight box which has four mounting lugs on one side. The antenna connection is made to the insulated terminal on one end and a coaxial cable from the Receiver is run through the terminal tube on the opposite end.

(6) BASIC DIFFERENCE BETWEEN MODEL DAS AND MODEL DAS-2.—The PRR switch and its circuits in the Model DAS-2 makes it possible to receive stations operating on a second basic pulse repetition rate. This nearly doubles the number of stations which may be received by the Model DAS-2 as compared to the Model DAS.

This book is written for both models of the equipment. Whenever the presence or lack of a PRR switch affects the subject matter, the variations are adequately described.

e. DIMENSIONS AND WEIGHTS.*

Unit	Height	Width	Depth	Weight
1. Radio Receiver Indicator, Type CG-46210 and CG-46210A (or B)	17½″	28 3/32″	22⅛″	210 lbs.
Receiver Unit only	4¾″	10″	19½″	20 lbs.
Power Supply Unit only	10¾″	10¾″	20½″	65 lbs.
Indicator Unit only	15¼″	10¾″	22″	45 lbs.
2. Antenna Loading Coil, CG-47335	11⅛″	7″	5½″	8 lbs.

*All weights include connectors and tubes.

f. ELECTRICAL SPECIFICATIONS.

(1) INPUT POWER.

Voltage .... 115 V. or 230 V. a-c
Frequency .... 50 to 60 cycles per sec.
Phase .... single
Watts
(a) Operation .... 300 w.
(b) Stand-by Heating.......................... 40 w.
Power Factor.. .96

(2) RECEIVER FREQUENCY.

(Curves of Sensitivity, Selectivity, and Video response may be found under Section V. Maintenance, Figs 5-1 to 5-7.)

Intermediate Frequency....................1100 kc

(3) CHANNEL AND CORRESPONDING OSCILLATOR FREQUENCIES.

Channel No.	Factory Setting	Tuning Range	Oscillator Range
1	1.950 mc	1.70 to 2.075 mc	2.80 to 3.175 mc
2	1.850 mc	1.70 to 2.075 mc	2.80 to 3.175 mc
*3	10.58 mc	9.90 to 12.10 mc	8.80 to 11.00 mc
*4	10.58 mc	9.90 to 12.10 mc	8.80 to 11.00 mc

*After completion of production these channels will be changed, by a coil kit, to cover the same ranges as channels number 1 and 2.

(4) INDICATOR UNIT CRYSTAL FREQUENCY—100 kc (crystal supplied).

Receiver Unit Crystal—None Required.

(5) HEAT DISSIPATION:

Indicator Unit	110 watts
Receiver Unit	34 watts
Power Unit	156 watts
Total	300 watts

g. VACUUM TUBE COMPLEMENT.

(1) INDICATOR UNIT (100 and 200 circuit symbol series).

Tube No.	Type	Function
V101	6SL7GT	Crystal Oscillator and Ten Microsecond Generator
V102	6SN7GT	Crystal Buffer and 1st Counter Blocking Oscillator
V103	6H6GT	1st Counter Gate
V104	6H6GT	2nd Counter Gate
V105	6SN7GT	2nd and 3rd Counter, Blocking Oscillators
V106	6H6GT	3rd Counter Gate
V107	6H6	4th Counter Gate
V108	6SN7GT	4th Counter Blocking Oscillator and Eccles-Jordan Input Gate
V109	6H6GT	Time Corrector and Eccles-Jordan Input Gates
V110	6SN7GT	Time Corrector, Square Wave Generator
V111	6SN7GT	Eccles-Jordan 25 cycle, Square Wave Generator
V112	6SL7GT	"Balance" Gain Control Amplifier
V113	6SN7GT	Balance Control Regulator
V114	6J5GT	10 Microsecond, Receiver, and Pedestal Mixer
V115	6SL7GT	Counter Test Cathode Follower
V116	6SL7GT	500 Microsecond Amplifier and Fixed Delay Input Gate
V117	6SL7GT	Marker Mixer and Trace Shift Mixer
V118	6H6GT	Step Feed-back Gate
V119	6SN7GT	Coarse Delay Multivibrator
V120	6SL7GT	Fixed Delay Multivibrator
V121	6H6GT	Pedestal Generator Input Gate
V122	‡6H6GT	Cathode Ray Tube Blanking Restorer

(1) INDICATOR UNIT (continued).

Tube No.	Type	Function
V123	6SN7GT	Sweep Generator Input Gate
V124	†6SK7	Sweep Generator
V125	6J5GT	Sweep Amplifier
V126	6SN7GT	Fine Delay Multivibrator
V127	6H6	Pedestal Generator Input Gate
V128	6SN7GT	Pedestal Generator
V129	5CP1	Cathode Ray, Indicator Tube

(2) POWER SUPPLY UNIT (300 circuit symbol series).

Tube No.	Type	Function
V301	5U4G	Low Voltage Rectifier
V302	6Y6G	Voltage Regulator
V303	6Y6G	Voltage Regulator
V304	6SL7GT	Regulator Amplifier
V305	VR150	Voltage Reference
V306	2X2	High Voltage Rectifier
V307	2X2	High Voltage Rectifier

(3) RECEIVER UNIT (400 circuit symbol series).

Tube No.	Type	Function
V401	6AC7	Radio Frequency Amplifier
V402	6SA7	Oscillator-Converter
V403	*6SG7	First I-F Amplifier
V404	6SK7	Second I-F Amplifier
V405	*6SG7	Third I-F Amplifier and Differential Gain
V406	6H6	Demodulator
V407	6AG7	Video Amplifier

* The 6SG7 tubes were replaced by 6SK7 tubes in Change No. 5 (see page 1-3 for serial numbers of units affected by Change No. 5).

† One 6SK7 tube was changed to one 6SJ7 in all Model DAS-2 units, and in Change No. 3. (See page 1-3 for serial numbers of units affected by Change No. 3.)

‡ Do not substitute a 6H6 metal tube.

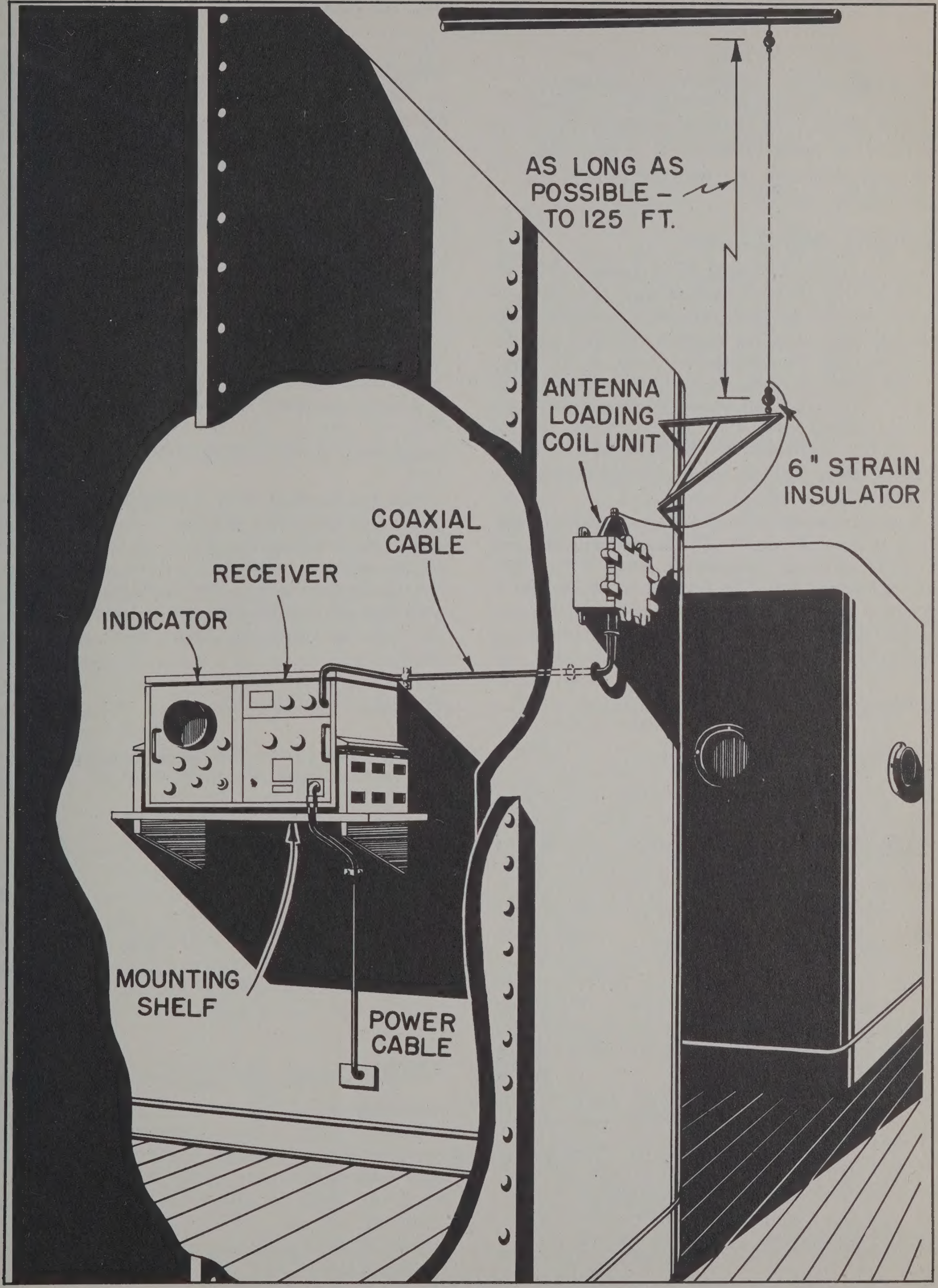

AS LONG AS POSSIBLE – TO 125 FT.
ANTENNA LOADING COIL UNIT
6" STRAIN INSULATOR
COAXIAL CABLE
RECEIVER
INDICATOR
MOUNTING SHELF
POWER CABLE

Figure 2-1—Model DAS Equipment Installation

II. INSTALLATION AND ADJUSTMENT

Note

If test equipment is available for pre-installation tests on the equipment, it is desirable, before installation, to perform the Maintenance Alignment to be found in Section V of this book. Receiver sensitivity and bandwith checks are particularly desirable.

1. ANTENNA INSTALLATION.

The antenna should be made from regulation No. 12, stranded, (Silicon-Bronze) antenna wire, and strung in a vertical position between two strain insulators. The length and location of the antenna will affect the efficiency and range (but not the accuracy) of the equipment, and should be given close attention. Find a place which is in the open and as free of masts and superstructure as possible, yet allows a long vertical antenna up to 125 feet, maximum. If it is impossible to suspend a length of more than 45 feet be especially careful to avoid any obstructions.

Connect one end of the antenna to a strain insulator fastened at the high point selected, and the other end to a strain insulator fastened, as nearly as possible, directly below the first. The outer end of a yardarm is suggested as a place for connecting the upper insulator, and a bracket on the side of the chartroom for connecting the other.

After the Loading-Coil Unit has been installed, an extension of the lower end of the antenna wire must be connected to it. The additional length should also be free from any obstructions and should be kept as short as possible. Be sure that this lead will not touch anything except the supporting insulators.

2. ANTENNA LOADING-COIL UNIT INSTALLATION.

Fig. 2-1 shows a nearly ideal arrangement of the equipment. It would be well to study the picture, and try to duplicate it wherever possible.

The Antenna Loading-Coil Unit should be close to the lower end of the antenna, so that the connection between the two may be kept short. In some cases this will necessarily place the coil a long distance from the Receiver-Indicator Unit, but keep these Units as close together as possible for convenience and ease of installation.

The Loading-Coil Unit is unaffected by weather because it is watertight and has a protective coating of paint. Summarizing, it is important to consider mounting convenience, nearness to antenna, and clearance for the interconnecting wire. The wiring should have a clear path between antenna insulator and Loading-Coil Unit and must not contact any object. Make sure it is out of reach.

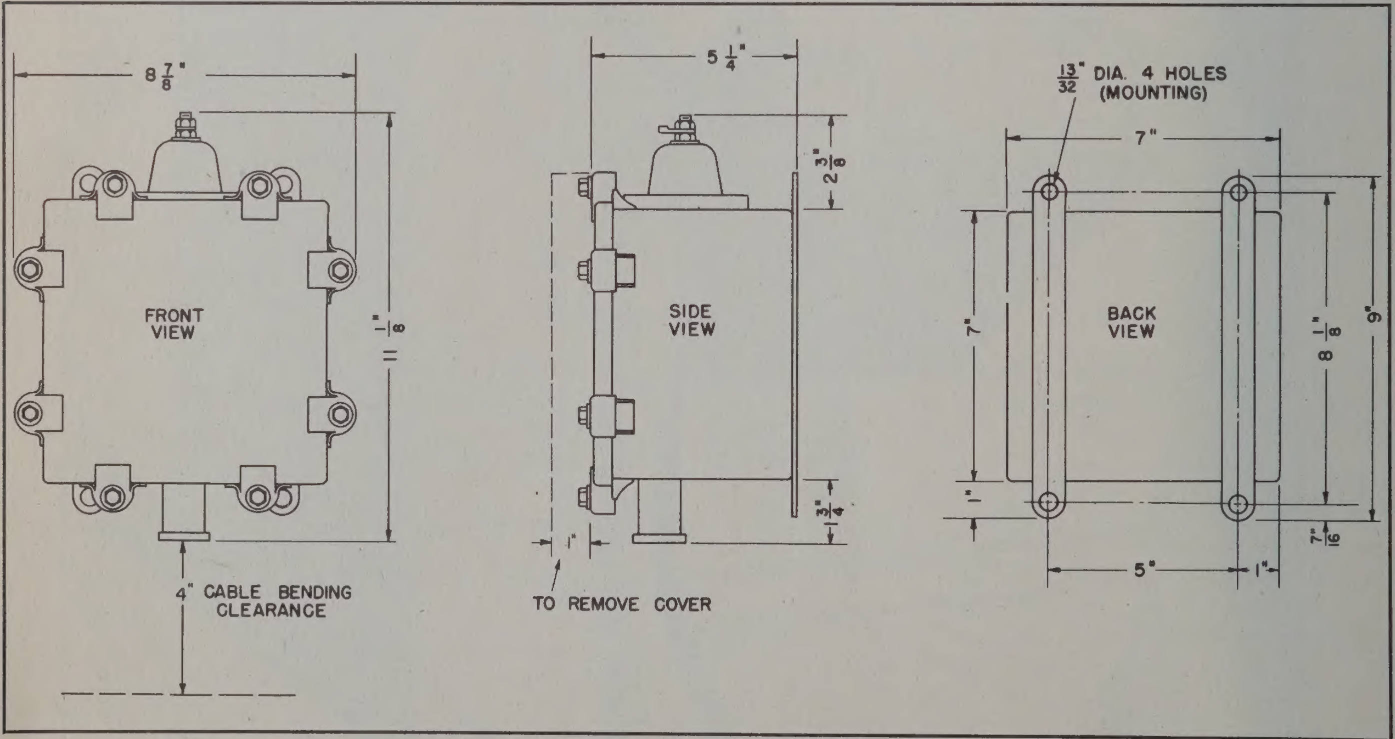


Figure 2-2—Antenna Loading-Coil Unit Outline Drawing

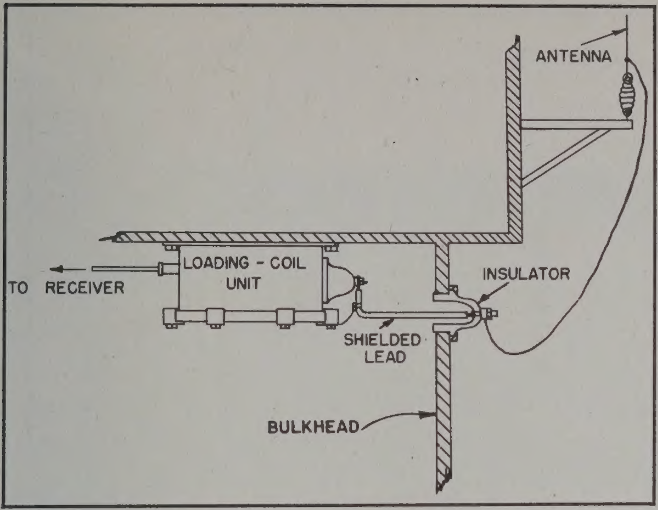


Figure 2-3—Antenna Loading-Coil Unit, Alternate Mounting Position

The mounting details for the Antenna Loading-Coil are as follows:

a. Drill four holes each 13/32 inch in diameter in the bulkhead where the unit is to be mounted, using the Loading-Coil Unit as a template. The outline drawing, Fig. 2-2, shows one position for mounting and the dimensions between holes. The coil may also be mounted in the position shown in Fig. 2-3. If the Loading-Coil is mounted inside of the chartroom, insulate the lead where it passes through the bulkhead and shield the part which is inside of the room, as shown in Fig.. 2-3. Keep the shielded lead as short as possible because it reduces the effective antenna length.

b. Fasten the unit to the bulkhead by means of four ⅜ inch (No. 20) bolts, using a lockwasher under each nut.

c. Connect the lead-in wire (No. 12 stranded antenna wire) from the lower end of the antenna to the terminal in the insulator on top of the unit. To provide positive contact, wrap the lead several times around the antenna and solder the joint. A soldering lug for the Loading Coil terminal connection is recommended.

d. A cable connection through the bottom of the unit and internal connections will be made later. For the present, however, this installation may be considered complete.

3. RECEIVER-INDICATOR UNIT INSTALLATION.

The Receiver-Indicator Cabinet in its cradle must be mounted in a protected area, and in a place where the operator will be in close communication with the Navigator. On cruisers, battleships, carriers, and other large vessels, it will usually be possible to install the unit at approximately eye-level somewhere in the chartroom. On smaller ships it may be located in the Radar control room, emergency cabin, or other compartments, depending upon the space available. In any case, convenience is the first consideration and it is thus advisable to consult the Navigator as to the most desirable location for this unit.

The weight of the complete unit is 210 lbs. and it will require a solid support. Either a strong table or a steel shelf, welded to bulkhead stiffeners, will serve adequately. If the shelf is used an effort should be made to keep the viewing screen in the Indicator located at eye level.

Sufficient space must be allowed on all sides of the cradle for tightening the mounting bolts, and in front of the Unit clearance is needed not only for the operator, but also for removal of the chassis from the cabinet. Space is particularly desirable to the left of the front panel for making adjustments to the Unit. Fig. 2-4 gives the dimensions for the clearances required, and the drilling plan for the eight mounting bolts. Drill eight holes, 13/32 inch in diameter in the shelf or table top and bolt the Unit in place with ⅜ inch (No. 20) bolts. Secure with lockwashers and nuts.

4. CABLING AND CONNECTIONS.

The Loading-Coil Unit must be connected to the Receiver Unit by means of a coaxial cable. Use RG10/U cable, Fig. 2-5, and keep it as short as the distance between the two units will allow. One end of the cable will be inserted in the Loading-Coil Unit through the terminal tube on the bottom, and the other end will be connected to the antenna connector which plugs in the receptacle on the Receiver panel. At intervals between the Units the cable should be securely fastened to the bulkheads by means of clamps.

When the cable has been strung, make the connections at its ends as follows:

a. RECEIVER CONNECTION.—The connector for the antenna cable is attached to a 90 degree plug adaptor in the upper right-hand corner of the Receiver-Indicator Unit. The adaptor is held in place in the receptacle by a snap spring, and should be removed by pulling straight out from the panel. The exploded view of the connector, Figs. 2-6 to 2-9 show the parts and how they fit together. Disassemble the connector and attach the antenna cable as follows:

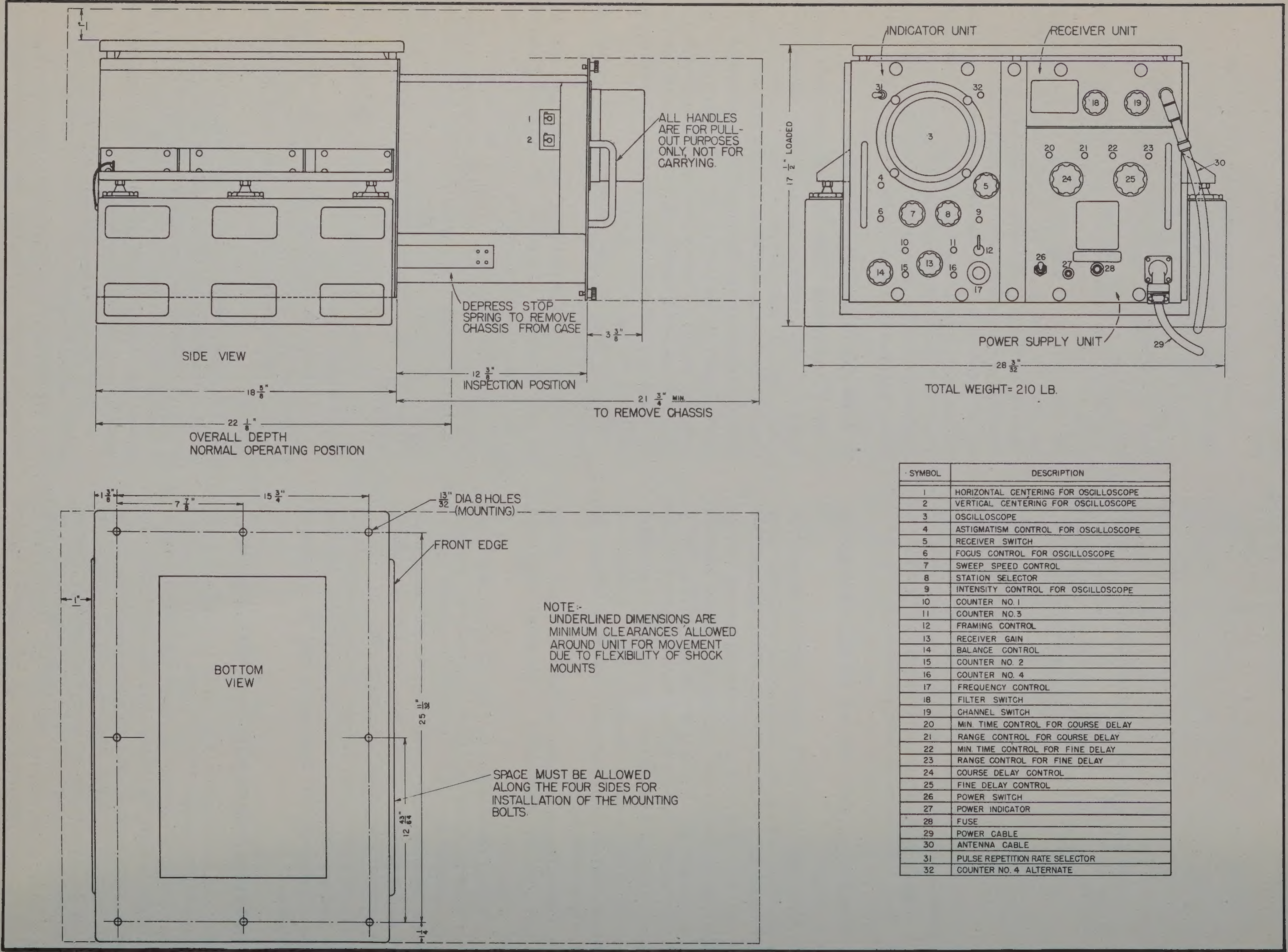
(1) Unscrew the outer sleeve (4) and slide it back on the middle sleeve (1).

(2) Pull the connector free of the 90 degree adaptor, as shown in Fig. 2-7. The 90 degree adaptor fingers, (10), over the snap ring (9), hold the two together.

(3) Hold the inner sleeve (5) with one hand and unscrew the middle sleeve (1) with the other (Fig. 2-8). As (1) is removed, be careful not to let the rings (2 and 3) or the key (7) drop out and be lost. (In some connectors the rings (2 and 3) are replaced by a single spacer which may be clamped to the cable).

(4) Remove the key (7) and slide the core (6) out of the inner sleeve (5).

(5) Remove the special terminal nut (8) from between the fingers in the core (6). The nut unscrews.


INDICATOR UNIT
RECEIVER UNIT
POWER SUPPLY UNIT
17 1/2" LOADED
28 3/32"
TOTAL WEIGHT= 210 LB.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
ALL HANDLES ARE FOR PULL-OUT PURPOSES ONLY, NOT FOR CARRYING.
DEPRESS STOP SPRING TO REMOVE CHASSIS FROM CASE
3 3/8"
SIDE VIEW
12 3/8"
INSPECTION POSITION
18 5/8"
21 3/4" MIN.
TO REMOVE CHASSIS
22 1/8"
OVERALL DEPTH
NORMAL OPERATING POSITION
1"
1 3/8"
7 7/8"
15 3/4"
13/32" DIA. 8 HOLES (MOUNTING)
FRONT EDGE
BOTTOM VIEW
1"
25 11/32"
12 43/64"
1 1/4"
SPACE MUST BE ALLOWED ALONG THE FOUR SIDES FOR INSTALLATION OF THE MOUNTING BOLTS.

NOTE:-
UNDERLINED DIMENSIONS ARE MINIMUM CLEARANCES ALLOWED AROUND UNIT FOR MOVEMENT DUE TO FLEXIBILITY OF SHOCK MOUNTS

SYMBOL	DESCRIPTION
1	HORIZONTAL CENTERING FOR OSCILLOSCOPE
2	VERTICAL CENTERING FOR OSCILLOSCOPE
3	OSCILLOSCOPE
4	ASTIGMATISM CONTROL FOR OSCILLOSCOPE
5	RECEIVER SWITCH
6	FOCUS CONTROL FOR OSCILLOSCOPE
7	SWEEP SPEED CONTROL
8	STATION SELECTOR
9	INTENSITY CONTROL FOR OSCILLOSCOPE
10	COUNTER NO. 1
11	COUNTER NO. 3
12	FRAMING CONTROL
13	RECEIVER GAIN
14	BALANCE CONTROL
15	COUNTER NO. 2
16	COUNTER NO. 4
17	FREQUENCY CONTROL
18	FILTER SWITCH
19	CHANNEL SWITCH
20	MIN. TIME CONTROL FOR COURSE DELAY
21	RANGE CONTROL FOR COURSE DELAY
22	MIN. TIME CONTROL FOR FINE DELAY
23	RANGE CONTROL FOR FINE DELAY
24	COURSE DELAY CONTROL
25	FINE DELAY CONTROL
26	POWER SWITCH
27	POWER INDICATOR
28	FUSE
29	POWER CABLE
30	ANTENNA CABLE
31	PULSE REPETITION RATE SELECTOR
32	COUNTER NO. 4 ALTERNATE

Figure 2-4—Receiver-Indicator Unit, Outline Drawing

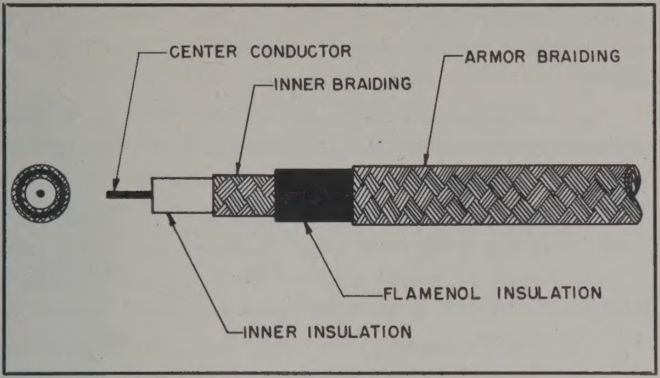

CENTER CONDUCTOR
INNER BRAIDING
ARMOR BRAIDING
FLAMENOL INSULATION
INNER INSULATION

Figure 2-5—Coaxial Cable RG10/U (CASSF-50-1A)

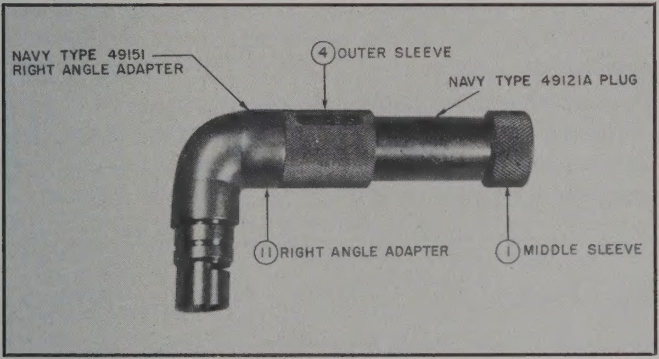

NAVY TYPE 49151 RIGHT ANGLE ADAPTER
4 OUTER SLEEVE
NAVY TYPE 49121A PLUG
11 RIGHT ANGLE ADAPTER
1 MIDDLE SLEEVE

Figure 2-6—Navy Type 49121A Connector, Assembled View

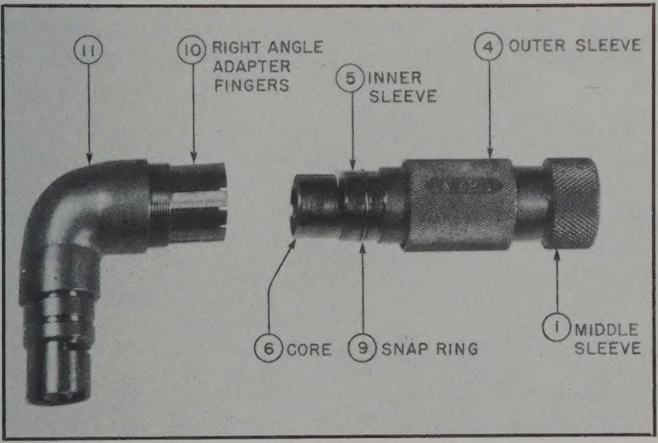

11
10 RIGHT ANGLE ADAPTER FINGERS
5 INNER SLEEVE
4 OUTER SLEEVE
6 CORE
9 SNAP RING
1 MIDDLE SLEEVE

Figure 2-7—Navy Type 49121A Connector, Partially Disassembled

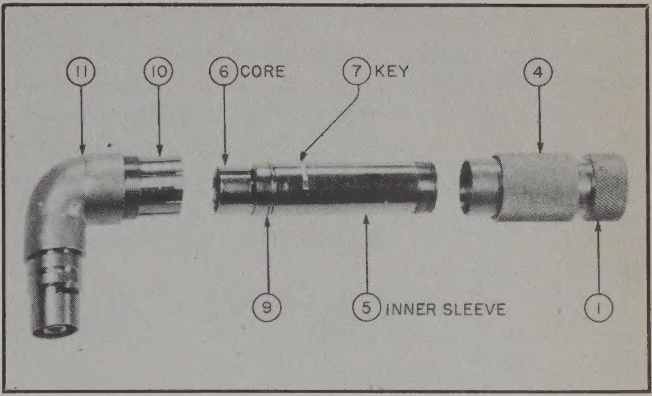

11
10
6 CORE
7 KEY
4
9
5 INNER SLEEVE
1

Figure 2-8—Navy Type 49121A Connector, Disassembled View

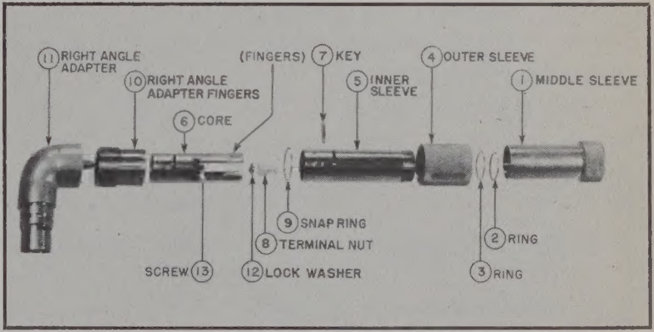

11 RIGHT ANGLE ADAPTER
10 RIGHT ANGLE ADAPTER FINGERS
6 CORE
(FINGERS)
7 KEY
5 INNER SLEEVE
4 OUTER SLEEVE
1 MIDDLE SLEEVE
9 SNAP RING
8 TERMINAL NUT
SCREW 13
12 LOCK WASHER
2 RING
3 RING

Figure 2-9—Navy Type 49121A Connector, Exploded View

(6) The connector and adaptor may be still further disassembled, as shown in Fig. 2-9, but this is unnecessary.

(7) Strip the end of the coaxial cable which is to be connected to the receiver as follows: First remove the braided armor, flamenol insulation jacket, and inner braiding from exactly ⅜ inch of the cable end. Next remove the inner insulation 5/16 inch from the end, leaving 1/16 inch of insulation extending beyond the armor and 5/16 inch of inner conductor exposed. Pull the armor back an additional ½ inch or more and cut off ½ inch of the flamenol insulation only. Then push the armor back over the inner braid so that it is tight around it. After scraping or cleaning the first ½ inch of the armor, the cable is ready for assembling.

(8) Thread the coaxial cable through the parts of the connector assembly in the order: (1); (2) and (3); (4); and (5). The snap ring (9) should already be in place on (5). (All part references are to Fig. 2-9).

(9) Screw a #6-32 bakelite plug into the special terminal nut removed from the connector, or in some way protect the threads in preparation for soldering the conductor in the terminal.

(10) Insert the end of the inner conductor of the cable 3/16 inch into the terminal part of the special nut (8) and solder it in place. Remove the bakelite plug, or whatever was used to protect the threads.

(11) Insert the cable, with the nut attached, into the core (6) in such a way that the metal fingers go on the outside of the cable armor. Turn the core during the operation so that the screw inside of it will go into the nut on the cable and draw the parts firmly together.

(12) Bend the fingers of the core down so that they will fit tightly against the conductor armor, then solder the fingers, armor, and inner braid together.

(13) Slide the inner sleeve (5) over the core (6) line up the two key-ways and replace the key (7).

(14) Slide the middle sleeve (1) through the outer sleeve, (4) and over the two rings (2 and 3).

(15) Slide the sleeve assembly (1, 2, 3, and 4) over the core assembly (5, 6, 7, 8, and 9), and holding the

core (5) screw the middle sleeve (1) firmly in place. The shield must go over the key before the internal threads will take hold.

(16) Push the 90 degree adaptor (10 and 11) over the end of the connector, making sure that the fingers on the adaptor (10) go on the outside of the snap ring (9).

(17) Screw the outer sleeve (4) in place over the adaptor fingers (10).

(18) The assembly is now complete, and the end of the adaptor can be pushed into the receptacle in the Receiver Unit panel.

b. LOADING-COIL CONNECTIONS.—The connection between the coaxial cable and the Antenna Loading-Coil Unit, and the internal connections to the Loading-Coil must still be made. Proceed as follows:

(1) Remove the eight bolts holding the cover on the Loading-Coil Unit.

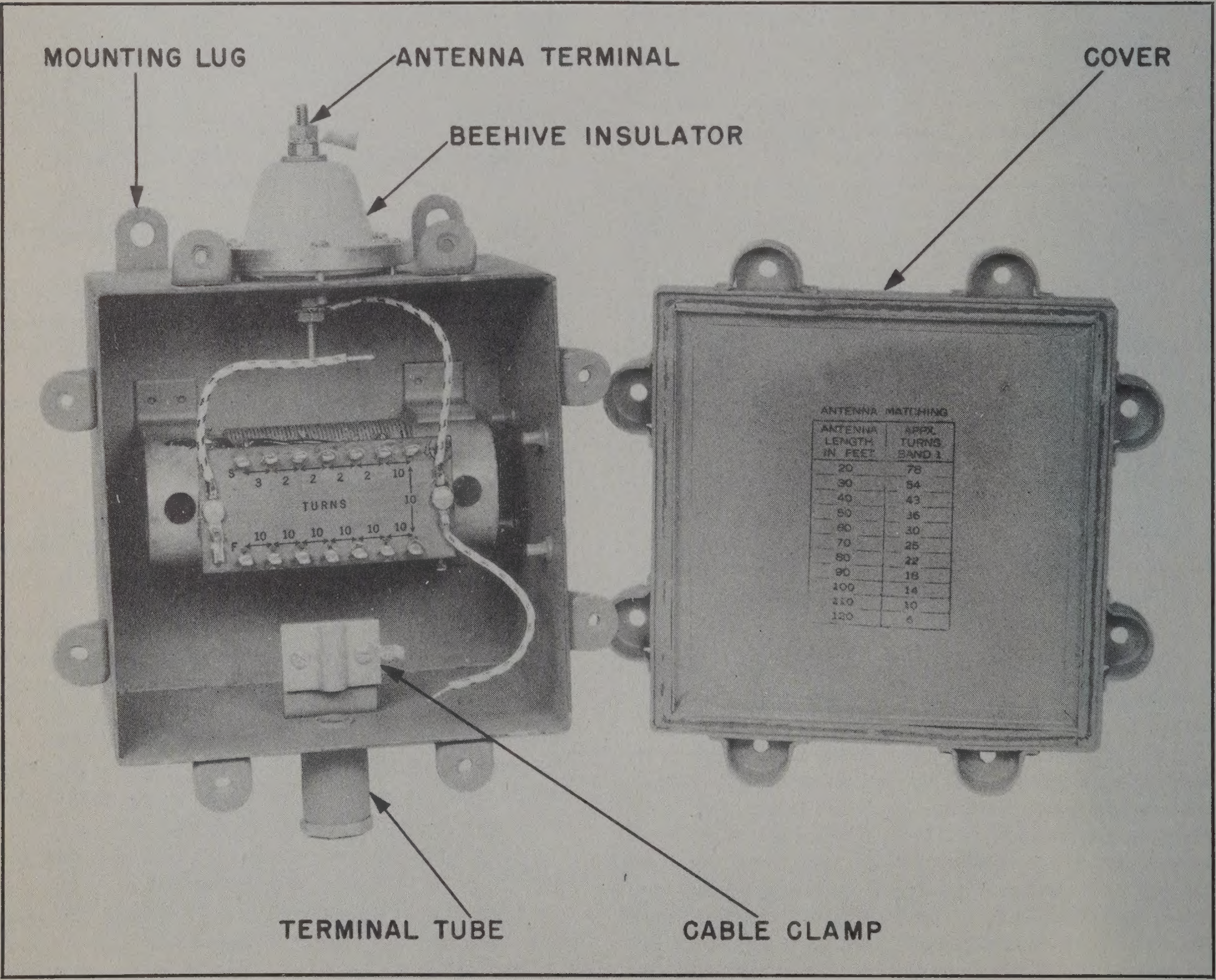
(2) Fig. 2-10 shows the unit with the cover removed. Just above the terminal tube at the bottom is a clamp, held in place by two screws, and under one screw is a solder terminal. Remove the screws, terminal, and clamp.

(3) Remove the plug and washer from the bottom of the terminal tube and slip them over the end of the coaxial cable, the nut first, then the washer.

(4) Strip the end of the cable back to about 5/16 inch from the end, removing all except the inner conductor. Remove 5 inches more of the armor and flamenol insulation, but leave the inner braid and inner insulation.

(5) Push the end of the cable through the terminal tube and up to where the center conductor will make contact with the solder clip on the terminal board. This clip is just to the left of the "F" stamped on the board, and held by one of the mounting screws as shown in Fig. 2-10.

(6) Bend the solder clip prongs over the center conductor and solder the connection. About ⅛ inch of the bare conductor should be exposed between the clip and the insulation on the cable.



ANTENNA MATCHING

ANTENNA LENGTH IN FEET	APPX. TURNS BAND 1
20	78
30	54
40	43
50	36
60	30
70	25
80	22
90	18
100	14
110	10
120	6

Figure 2-10—Antenna Loading-Coil Unit, Cover Removed

(7) Hold the cable against the bracket just above the terminal tube and replace the clamp and solder lug so that it holds the cable firmly. The clamp will make contact with the inner braid only.

(8) Unravel the inner braid of the cable from the end, down to the clamp and twist the unraveled wires together to form a stranded lead. Cut to a length of two inches and solder the end in the solder clip under one of the cable clamp screws.

(9) On the inside of the cover to the Unit is an Antenna Matching table. Determine the length of your antenna, including the lead-in wire to the Loading-Coil, and find approximately this length on the table. Opposite the length find the number of turns of the coil required for matching it .

(10) The two leads in the Unit, each with a free end, must be connected to the coil terminals in such a way that the desired number of turns are included between the two connections. Between each pair of terminals are the number of coil turns indicated by the figure stamped on the board. If connections are made to two adjacent terminals with a "10" between them, ten turns will be inserted in the circuit. If one wire is connected to one terminal, the next terminal is skipped, and the other wire is connected to the third terminal, the sum of the turns indicated by both figures stamped between the connections are inserted. Select the proper combination of terminals for matching your antenna, as determined from the table, and temporarily twist the leads around the terminals. (Final adjustment of the Loading-Coil must be made with signals.

(11) The washer and plug must be replaced in the terminal tube, with a water resistant material between them. First push the washer as far up into the tube as it will go, and then fill the tube with a metallic, waterproof packing material. Replace the plug and screw it in firmly.

c. POWER CONNECTION.

CAUTION

Before making any power connections to the Receiver-Indicator Unit, be sure that the "ON-OFF" switch on the front panel of the power supply is turned to "OFF".

Locate a convenient power outlet in the compartment or chartroom, and make sure it will supply the proper voltage and frequency. A frequency of 50 to 60 cycles at 115 or 230 volts is required for the Unit, and if only d-c or another frequency is available, a motor generator set must be used for the supply. If 115 or 230 volts are not available, a transformer must be used. The output of any such M-G set or transformer should be at least 300 watts at 115 or 230 volts, 50 to 60 cycles, and have good wave form. If large fluctuations in voltage are anticipated, a regulator should be used in the circuit.

To make power connections proceed as follows:

(1) Cut a sufficient length of two conductor power cable to reach from the outlet to the Unit and prepare to make the Unit connection first.

(2) At the lower right-hand corner of the Unit is the A-N power connector, held in place by a threaded collar. Unscrew the collar and pull the connector straight out from the panel.

(3) Four screws hold the two sections of the connector together; remove the screws and separate the parts.

(4) Two screws hold a clamp in place on one section of the connector; loosen the screws and slip the power cable through the clamp and 90 degree angle section of the connector.

(5) Strip 3/16 inch of insulation from the end of the cable, leaving the two bare conductors. Insert one in each terminal of the plug portion of the connector, and solder in place.

(6) Reassemble the two halves of the connector, replacing all four screws.

(7) Tighten the two clamp screws so that the cable is held firmly.

WARNING

The plug should not be connected to the power supply unit until after the unit has received a visual inspection and the cathode ray tube has been installed.

(8) At the other end of the power cable attach whatever type of plug or connection is required, and install the M-G set or transformer if necessary.

5. PREPARATION FOR USE.

a. MISCELLANEOUS.—The Receiver-Indicator is complete as received, with all parts except the cathode ray tube installed. A quick inspection should be made for any damage caused in shipping, either to the controls or the tubes. Loosen the six thumbscrews around the edges of the front panel, remove the center panel section, and slide the unit chassis out of the cabinet to the inspection position, as shown in Fig. 1-3.

WARNING

Be sure the power connection is removed. This equipment is not supplied with interlocks and employs voltages (2200 volts) which are dangerous to life.

Inspect all of the tubes for signs of damage, and where replacements are necessary, take them from the spare parts provided with the equipment. Turn all of the front panel control knobs back and forth to check for binding or loose couplings. If any of the set screws on the knobs or couplings have become loose in shipping, tighten them using the Allen wrenches clamped to the right-hand side of the Power Supply Unit. After checking, turn all of the controls as far counterclockwise as they will go.

b. FUSES.—Unscrew the bakelite fuse cover on the front panel of the Power Supply Unit, and remove the fuse. To operate on a 115 volt supply, a 5-amp. fuse is needed; to operate on a 230 volt supply, a 2-amp. fuse is required. Select and install the right value fuse for your supply voltage. Fuses of both values are attached to the same transformer case that holds the Allen wrenches.

c. POWER SELECTION SWITCH.—At the extreme rear of the Power Supply Unit chassis, between the large transformer on one side, and a row of tubes on the other, is a toggle switch, S302. This switch connects heaters and transformers in parallel for 115 volt operation, and in series for 230 volts. If your supply is 230 volts, throw this switch to the rear, and if it is 115 volts, throw it to the front.

d. CATHODE RAY TUBE.

CAUTION

The cathode ray tube is highly evacuated, and subject to very great air pressure. If it is broken, glass and metal fragments will be violently expelled, causing possible personal injury. Handle with extreme care, using safety goggles, gloves and heavy clothing.

The cathode ray tube must be inserted through the front panel of the Indicator Unit. Loosen the four knurled thumbscrews holding the light shield to the panel (Fig. 1-3) and remove the shield, lens, and rubber gasket.

(1) Unpack the cathode ray tube from its carton.

(2) Push the tube through the front panel into the double shield in the Indicator Unit. The base of the tube must be aligned with the socket before the tube can be inserted. Rotate the tube against the socket until the two are aligned, then seat the tube flush against the socket.

(3) Hanging from the top terminal board is the heavily insulated anode lead. At the end of the lead is a rubber cup with a clip at its center. Push the clip over the rounded pin on the side of the tube. This pin is visible through the hole in the left-hand side of the double tube shield.

(4) The cathode ray tube socket is held to the vertical chassis by wing nuts and thumbscrews at the extreme rear of the Unit. Loosen these screws three or four turns and move the tube and socket toward the back.

(5) Replace the light shield, lens, and rubber gasket on the front panel with the gasket in contact with the cathode ray tube. Tighten the four captive thumbscrews.

(6) Push the power plug into the receptacle on the front panel of the Power Supply Unit, and secure it by means of the threaded collar.

WARNING

The stand-by space heaters are ON when the power switch is OFF. These heaters have uninsulated terminal screws with 115 or 230 volts on them. Do not touch these terminals or allow them to contact metallic parts. Do not touch the heaters, as they may be quite hot. Fig. 1-3 shows the location of the heaters.

(7) Turn the equipment on and inspect the cathode ray tube screen for horizontal traces. If the sweep across the tube is not level, loosen the thumb screws around the light shield and the screws in the collar around the tube socket, then rotate the tube from the rear.

BEWARE OF HIGH VOLTAGE (2000 VOLTS) CIRCUITS.

(8) When the traces are level, turn the equipment off and tighten the thumbscrews holding the cathode ray tube socket. Do not let the tube rotate, and avoid undue pressure when tightening the screws.

6. INSTALLATION ADJUSTMENTS.

(To Be Made By Radio Technicians Only.)

a. POWER SUPPLY ADJUSTMENT.—Perform the *Maintenance Alignment of the Power Supply Unit* as described on Page 5-3.

b. PRELIMINARY TUNING OF THE ANTENNA LOADING-COIL.—Turn to the Maintenance section, page 5-6, and tune the antenna as directed.

c. ALIGNMENT OF THE INDICATOR UNIT.—Turn to the *Maintenance Alignment of the Indicator,* page 5-3, and completely check and align the equipment as directed.

d. ALIGNMENT OF THE RECEIVER UNIT.

(1) Tune the r-f stage of the receiver as directed on either page 5-7 page 5-8 in the Maintenance Section. Alignment on actual signals is to be preferred.

(2) Check sensitivity and bandwidth if a signal generator is available (see Maintenance, page 5-9).

e. FINAL TUNING OF THE ANTENNA LOADING COIL.

(1) Retune the Loading-Coil on actual signals, and make solder connections.

III. OPERATION

Note

Since the Model DAS or DAS-2 equipments will usually be operated by non-electronically trained navigators or quarter-masters, technical references other than the names of the controls will be kept at a minimum in this section of the book.

The LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278) should be read by all operators, as the necessary theory of the LORAN system and detailed interpretation and use of signal patterns are described therein. This operation section explains only the details of manipulation of DAS and DAS-2 equipments under the simplest signal conditions, and the simplified alignment of the equipment by operators.

1. DESCRIPTION; OPERATING CONTROLS.

A front view of the equipment is shown in Fig. 3-1. The large cabinet contains the Receiver, Indicator and Power Supply units, with the screen of the Cathode Ray Tube at the upper left. The left-hand unit is the Indicator, and the top unit on the right is the Receiver. The lower right-hand unit is the Power Supply. Antenna and power connections are made through receptacles on the front of the units. A small, steel, waterproof box (Fig. 1-8) at the base of the antenna contains an antenna tuning coil.

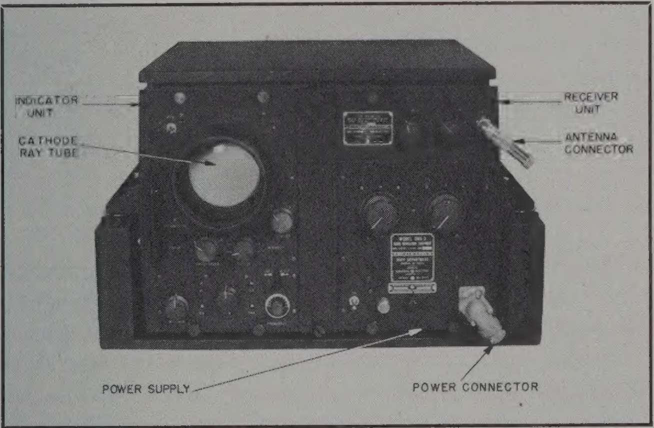


Figure 3-1—Model DAS-2 Receiver-Indicator Unit, Navy Type CG-46210, Front Panel

One important feature of the equipment is that it is not possible to damage or misalign it by any manipulation of the knobs on the front panel. It is also impossible to permanently damage the equipment by turning any of the adjusting screws, but it is possible to put the equipment out of alignment. Therefore screws should be turned only when the alignment check and alignment methods are fully understood.

The operating controls are as follows: (The number in parenthesis immediately following the title of the control refers to the number on Fig. 3-2.)

a. ON-OFF POWER SWITCH AND FUSE.—This switch controls power application to the entire equipment. When in the OFF position, auxiliary heaters are connected to reduce effects of humidity and decrease warm-up time. The pilot light (27) is illuminated when the ON-OFF switch is ON. The intensity can be controlled by turning the rim of the indicator. The FUSE (28) for the equipment is located next to the pilot light.

b. CONTROLS FOR SELECTING THE DESIRED PAIR OF STATIONS.

(1) CHANNEL switch (19) (with positions 1 to 4) is incorporated for selecting the desired radio frequency channel, as follows:

Channel No.	Factory Setting	Tuning Range
1	1.950 mc	1.70 mc to 2.075 mc
2	1.850 mc	1.70 mc to 2.075 mc
*3	10.58 mc	9.90 mc to 12.10 mc
*4	10.58 mc	9.90 mc to 12.10 mc

* Will have same range as channels No. 1 and 2 after the coil kit is added.

(2) PRR switch (31) (on Models DAS-a and DAS-2 only) with positions L and H is used to select a *basic pulse recurrence rate* corresponding to that of the desired pair of stations. (The Model DAS equipments are inherently set to "L" and cannot receive stations operating at the "H" basic pulse recurrence rate.) This switch is supplied as a modification kit for the DAS equipments, which when modified are known as DAS-a.

(3) STATION switch (8) with positions 0 through 7 is used for selecting the *specific pulse recurrence rate,* corresponding to that of the desired pair of stations.

c. CONTROLS FOR OBTAINING THE SEQUENCE OF OSCILLOSCOPE PATTERNS NECESSARY FOR A READING.

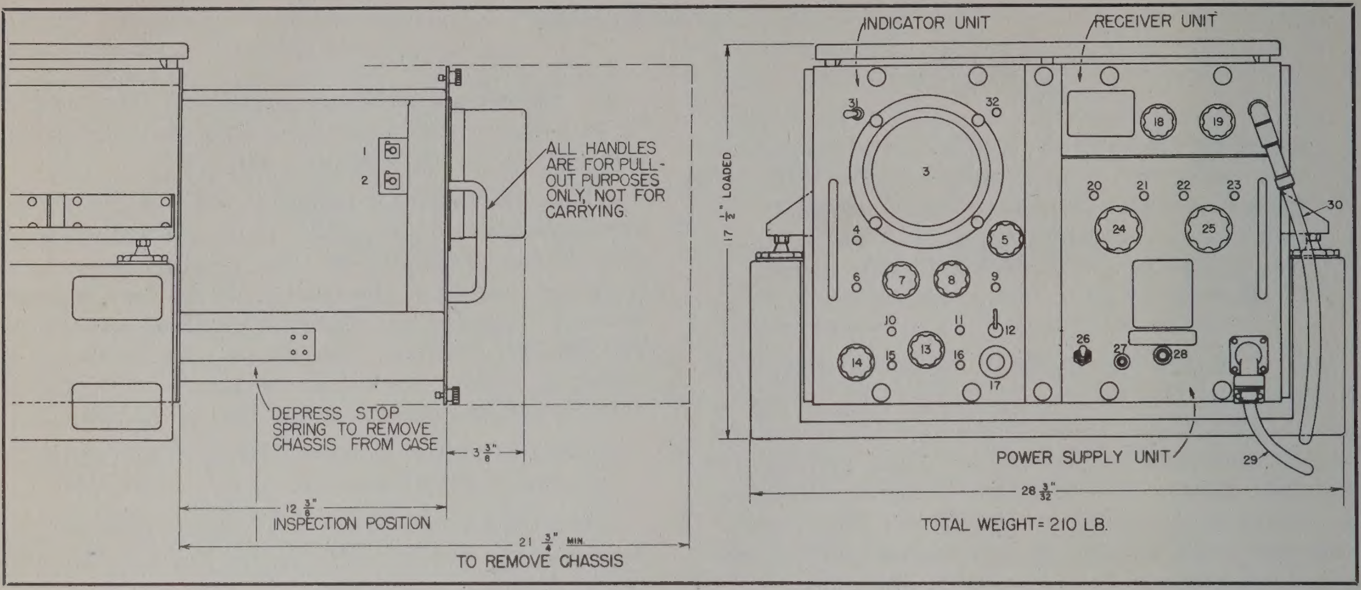
(1) RECEIVER switch (5) with four positions.

OFF: Signals from receiver are removed from scope (cathode ray tube).

ON: Signals from receiver are applied to scope.

CAL. 1: Provides a pattern to check alignment of indicator (Second counter adjustment "C2" and STATION selector switch).

CAL. 2: Provides pattern to check alignment of indicator (Third counter adjustment "C3"


INDICATOR UNIT
RECEIVER UNIT
1
2
ALL HANDLES ARE FOR PULL-OUT PURPOSES ONLY, NOT FOR CARRYING.
DEPRESS STOP SPRING TO REMOVE CHASSIS FROM CASE
3 3/8"
12 3/8"
INSPECTION POSITION
21 3/4" MIN
TO REMOVE CHASSIS
17 1/2" LOADED
3
4
5
6
7
8
9
10
11
12
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14
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24
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26
27
28
29
30
31
32
POWER SUPPLY UNIT
28 3/32"
TOTAL WEIGHT= 210 LB.

Figure 3-2—Receiver-Indicator Unit, Front Panel Outline

and Fourth counter adjustments "C4" or "C4A" and "C4B").

(2) SWEEP SPEED switch (7) with five positions;

POSITION 1: Provides slow sweep (each trace shows nearly one-half of pulse recurrence interval. Sweep length 19500 microseconds on "L", PRR, 14500 microseconds on "H" PRR). Wide trace separation.

POSITION 2: Provides fast sweep of about 2300 microseconds duration. (Portions on top of pedestals of slow sweep expanded to entire screen width.) Medium trace separation.

POSITION 3: Provides fast sweep of about 650 microseconds duration. (Left portion of each trace of number 2 sweep expanded to entire screen width.) Medium trace separation.

POSITION 4: Provides fast sweep of about 160 microseconds duration. (Left portion of each trace of number 3 sweep expanded to entire screen width.) Small trace separation.

POSITION 5: Provides same fast sweep as position 4 except no trace separation.

(3) LEFT-RIGHT switch (12) for shifting the position of the signals on the traces. An appropriate drift speed is automatically provided for the various sweep speeds.

(4) FREQUENCY dial (17) which is adjusted to exactly stop slight drifting of received pulses.

(5) COARSE DELAY control (24) for moving the lower pedestal in jumps of 500 microseconds.

(6) FINE DELAY control (25) for moving the lower pedestal smoothly by intermediate amounts.

(7) GAIN control (13) for adjusting the amplitude of signals on the scope.

(8) BALANCE control (14) for balancing the amplitude of pulses on the upper and lower traces.

(9) FILTER IN-OUT switch (18) for reducing certain kinds of interference. (Normally used in the OUT position.)

The screwdriver controls on the front panel are described in the *Simplified Alignment Procedure for Operators*, page 3-10.

2. OPERATING ALIGNMENT CHECK.

The following alignment check should be followed whenever the equipment is turned on, particularly when the operator is inexperienced. Although the description is rather lengthy, the actual operation takes less time to perform than to describe, and with practice the entire check can be accomplished in a few minutes. Methods of aligning the equipment, if the patterns are not in accordance with the description here, are covered on page 3-10.

a. Turn the ON-OFF switch to ON *and allow the set to warm up for at least 15 minutes so that all circuits can stabilize.* Very often a set which acts erratic at first will settle down after the warm-up period.

b. Set SWEEP SPEED switch to position 1;
Set RECEIVER switch to OFF;
Make sure the FILTER switch is OUT;

Set the FREQUENCY dial at mid-scale;

Set the PRR switch to "L". (If your set does not have a PRR switch, the set is inherently set to L.)

Set the STATION switch to position O.

Turn the COARSE DELAY and FINE DELAY controls fully counterclockwise.

The pattern should now appear like Fig. 3-3. The longest markers extending downward are 2500 microsecond markers. The slightly shorter ones are 500 microsecond markers. *The top or "A" pedestal should have its leading (left) edge coinciding with the first 2500 marker,* which is four 500 microsecond spaces over from the beginning of the top trace (the first "500" microsecond interval is blanked out or made invisible by the circuits in the indicator). If the bottom or "B" pedestal is jittery, adjust the COARSE DELAY slightly. Then turn the COARSE DELAY clockwise to check that the lower pedestal moves from underneath the upper pedestal over to at least the sixth 2500 microsecond marker.

c. Now turn the SWEEP SPEED switch to position 4. The pattern should appear like Fig. 3-4. Small upward pointing 10 microsecond markers and longer downward pointing 50 microsecond markers will be seen. Depending upon the adjustment of the DELAY dials, a longer downward pointing 500 microsecond marker and possibly a still longer downward pointing 2500 microsecond marker may be seen. These 500 and 2500 markers will be displaced to the right of a 50 microsecond marker and should be neglected at this stage. *There must be four 10 microsecond markers between each pair of 50 microsecond markers, dividing the 50 microsecond interval into five spaces. If not, the equipment is out of adjustment.*

d. Turn the FINE DELAY knob until a 50 microsecond marker on the upper trace points toward a 10 marker on the lower trace. Then turn the SWEEP SPEED control to position 5 and readjust the FINE DELAY control slightly so that the 10 markers on the two traces are exactly coincident (neglecting the places where a 10 marker of one trace is over a 50 marker of the other trace). See Fig. 3-5. Now turn the SWEEP SPEED back to position 4 and each 50 microsecond marker on the upper trace should point exactly to the tip of a 10 microsecond marker on the lower trace, as shown in Fig. 3-6. *This condition must exist, or all readings obtained will be in error by the amount of the misalignment of the 50 and 10 microsecond markers.*

e. Turn the RECEIVER switch to CAL. 1 and the SWEEP SPEED switch to position 3. A pattern as shown in Fig. 3-7 should be seen. *There must be ten steps on each trace.* (Part of the first step should be missing.) Then, when the STATION switch is turned to 1, the top step in each group should disappear, leaving 9. As the STATION switch is turned to successive positions, the number of steps should decrease. *The STATION switch*

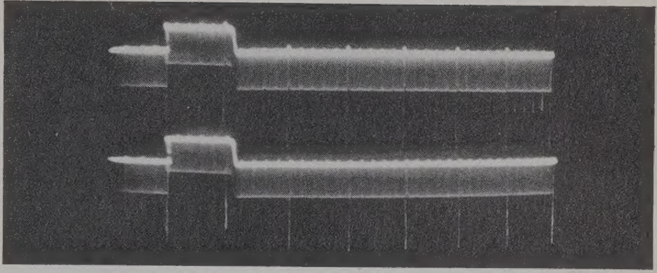

Figure 3-3—Oscillogram, Sweep Speed No. 1, Receiver Off

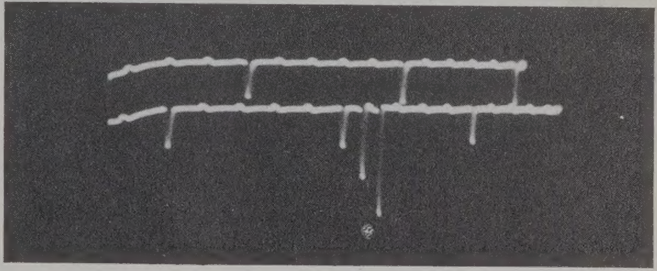

Figure 3-4—Oscillogram, Sweep Speed No. 4, Receiver Off

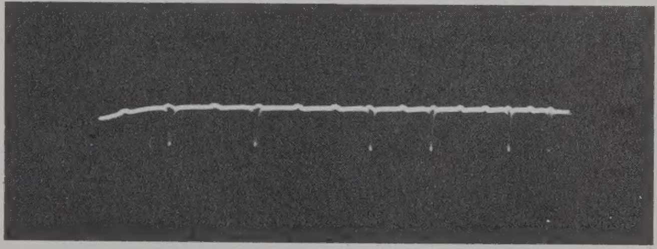

Figure 3-5—Oscillogram, Sweep Speed No. 5, Receiver Off, 10 Microsecond Markers Aligned

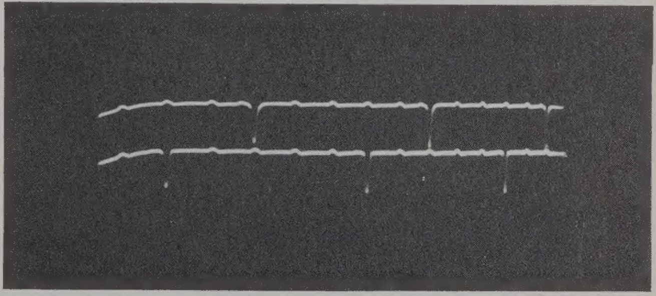

Figure 3-6—Oscillogram, Sweep Speed No. 4, Receiver Off, 10 and 50 Microsecond Markers Aligned

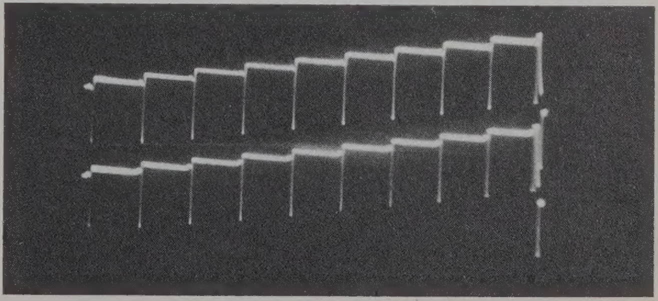

Figure 3-7—Oscillogram, Sweep Speed No. 3, Receiver CAL. 1, Station 0

setting, plus the number of steps remaining, must equal 10 for each position. When position 7 is reached, there should be 3 steps remaining, as shown in Fig. 3-8. If not, the equipment is out of alignment.

f. Now switch PRR to H (if your set has a PRR switch) and repeat the process of checking the STATION selector switch. Then switch PRR back to L.

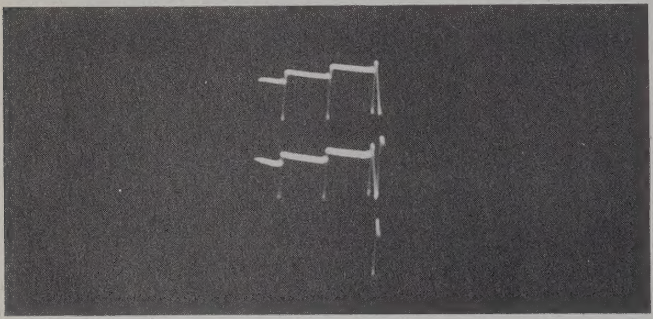

Figure 3-8—Oscillogram, Sweep Speed No. 3, Receiver CAL. 1, Station 7

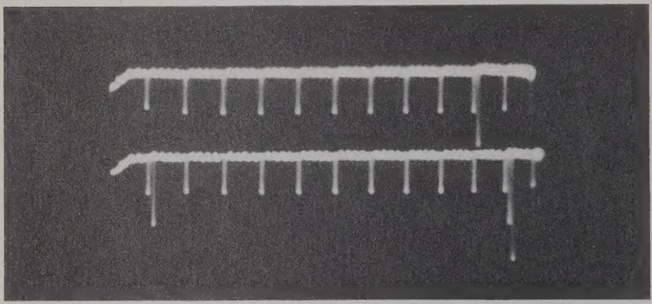

Figure 3-9—Oscillogram, Sweep Speed No. 3, Receiver Off

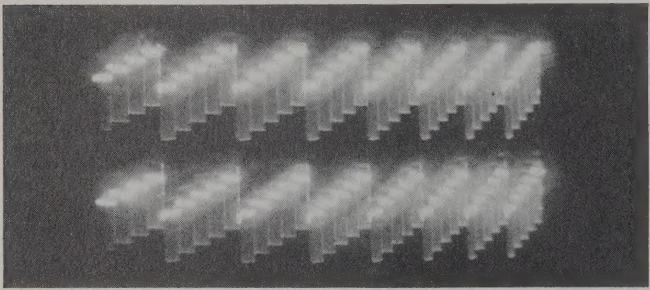

Figure 3-10—Oscillogram, Sweep Speed No. 1, Receiver Cal. 2, PRR on L Rate

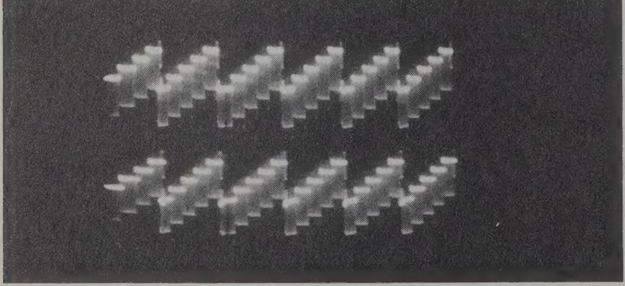

Figure 3-11—Oscillogram, Sweep Speed No. 1, Receiver CAL. 2, PRR on H Rate

g. Now turn the RECEIVER switch to OFF. Turn the FINE DELAY knob slightly, if necessary, until two long downward pointing 500 micro-second markers are seen on the lower trace with shorter downward-pointing 50 microsecond markers between. The pattern will look like Fig. 3-9, with the 50 microsecond markers dividing the 500 interval into ten spaces. (There will be nine 50 markers between the 500 microsecond markers, plus an additional 50 microsecond marker not quite coincident with a 500 microsecond marker.) A still longer downward pointing 2500 microsecond marker may be seen to the right of a 500 microsecond marker. It should be neglected. *The lack of coincidence of the 50, 500, and 2500 microsecond markers is inherent to the equipment and does not affect the accuracy of the reading.*

Check that the FINE DELAY knob shifts the lower trace at least 500 microseconds as it is moved from completely counterclockwise to completely clockwise. This can be easily done by counting the 50 microsecond markers on the lower trace as they move past the 500 microsecond marker on the upper trace and checking that at least 10 markers move past. (There is no need that any particular markers on the upper and lower trace be lined up at either end of the knob range, merely that a total shift of at least 500 microseconds occurs.)

h. Now turn the RECEIVER switch to CAL. 2, and the SWEEP SPEED switch to 1. A pattern like Fig. 3-10 should appear. *There must be eight groups of steps on each trace and each group should contain five steps, except the first (left) group, which should have only four.* If not, the equipment is out of alignment.

Note

When counting groups of steps, look closely to make sure that there are not additional groups just at the edge of the screen.

i. Now switch PRR to H (if your set has a PRR switch) and *the last two groups (right) of steps on each trace should disappear, leaving six groups of steps on each trace, with five steps in each group except the first, which should have four,* as shown in Fig. 3-11. If not, the equipment is out of alignment.

j. The alignment check is now complete. If there is any question about the alignment check procedure, or if the patterns do not appear as described a Radio Technician should be consulted, as the results obtained depend upon the equipment being properly aligned.

If it is intended to use only certain basic or specific pulse recurrence rates, then only these need be checked; however, when learning, be sure to check them all.

3. OPERATION; MAKING A READING.

a. Assuming the set has been turned on and warmed up, and the alignment checked in accordance with the preceding section, check that the SWEEP SPEED is on

No. 1, RECEIVER switch ON, BALANCE control centered, and FILTER in the OUT position.

b. Consult the Loran Tables or Charts to see what stations are to be expected. It will be noted on the table or chart, that each station pair is assigned identifying symbols, for example, 2, L, 4. The first figure indicates the channel number and corresponds to the setting on the CHANNEL switch, the middle letter indicates the setting of the PRR switch and the last figure gives the STATION switch setting. Thus it is merely necessary to set the CHANNEL, PRR, and STATION switches for the desired pair of stations. (Remember, if the set has no PRR switch it is inherently set to L). Then turn up the gain until stationary pulse signals (appearing as upward projecting vertical lines) are seen. Conversely, if it is not known which stations will be received, turn up the GAIN control until noise ("grass") about 1/4 inch high is seen on the traces, and try various combinations of CHANNEL, PRR, and STATION switch settings until stationary pulse signals are seen on the scope as shown in Fig. 3-12. *Under the simplest radio wave propagation conditions, only one pulse—a steady ground wave—will be received from each station of the pair, and the following description assumes this to be the case.*

c. The pulses may appear anywhere on the traces. Slide them along the traces by use of the LEFT-RIGHT switch until one pulse is on the top pedestal, and the other is on the bottom trace and to the right of the one on top, as shown in Fig. 3-13. When they are so arranged, the one on top is the "A" or MASTER station pulse and the one on bottom is the "B" or SLAVE station pulse. If both pulses are on the top trace, or if the pulse on the bottom trace is to the left of the one on the top, the wrong pulse has been placed on the top pedestal, and further manipulation of the LEFT-RIGHT switch is needed. Ignore any pulses from stations with other recurrence rates which will be moving across the screen.

CAUTIONS

(1) There is an interval of 150 to 500 microseconds (depending upon the STATION SETting) at the start of each trace that is "blanked out" or invisible. One pulse may, by chance, be in this portion when the equipment is first set to a pair of stations. If only one pulse is seen, push the LEFT-RIGHT switch one way or the other to see if another pulse shows up.

(2) If the pulse on the bottom trace has sufficient amplitude, it may project through the top trace; do not be confused by this.

(3) If either station is BLINKING (on-off or sideways-shifting) do not attempt to take a reading.

d. The stronger pulse should be adjusted to about the same amplitude as the weaker by means of the BALANCE control and then both should be made about one inch high with the GAIN control as shown in Fig. 3-14.

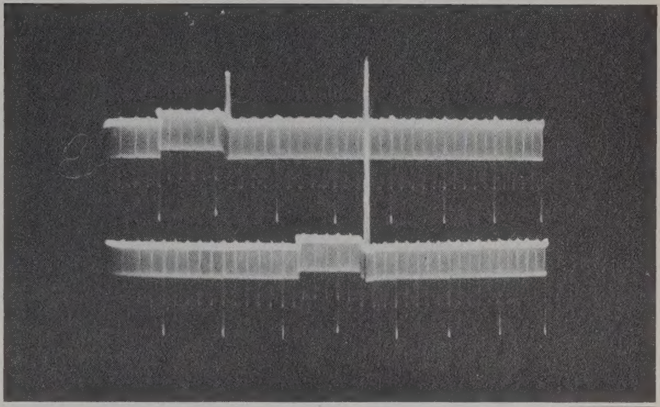

Figure 3-12—Oscillogram, Sweep Speed No. 1, Receiver ON, Showing Pulses Before Alignment

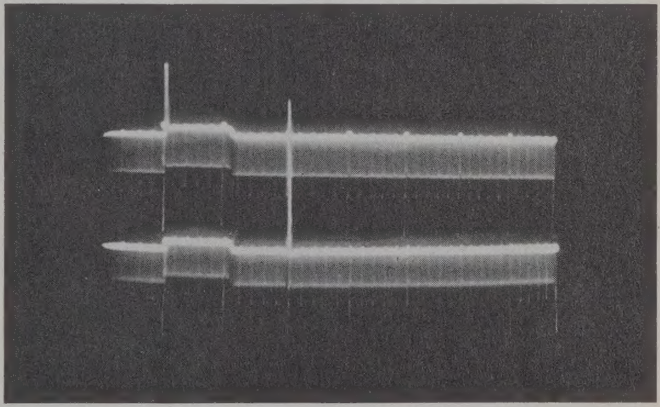

Figure 3-13—Oscillogram, Sweep Speed No. 1, Showing the A Pulse on the A Pedestal

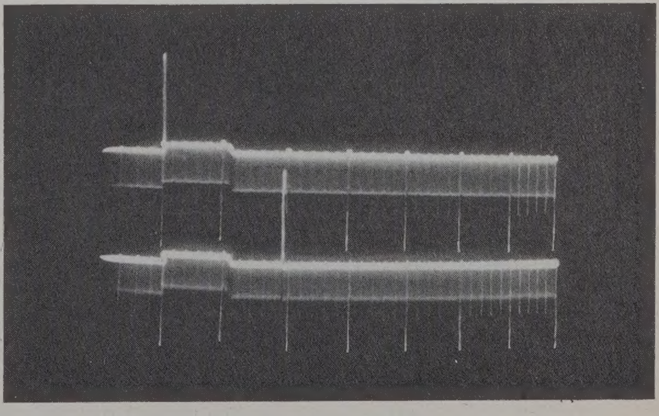

Figure 3-14—Oscillogram, Sweep Speed No. 1, Showing Pulses Properly Balanced

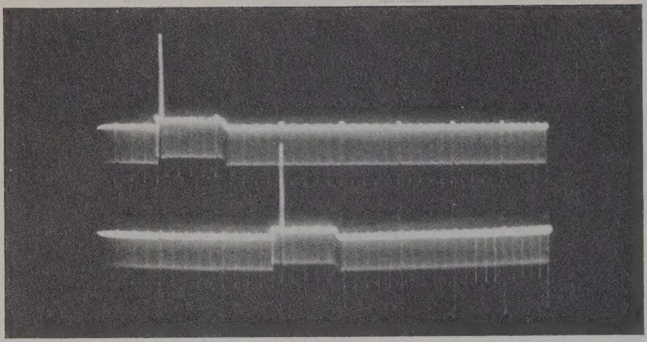

Figure 3-15—Oscillogram, Sweep Speed No. 1, Showing the B Pedestal Under the B Pulse

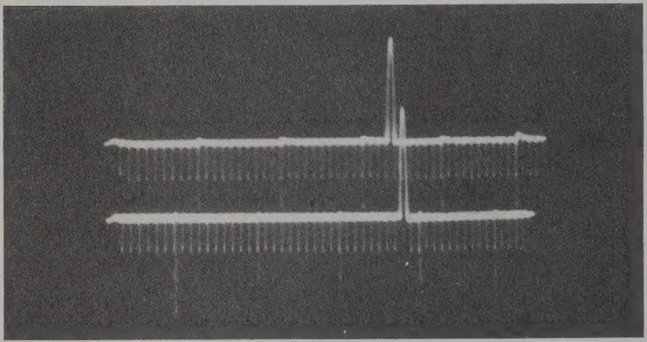

Figure 3-16—Oscillogram, Sweep Speed No. 2, Before Aligning Pulses

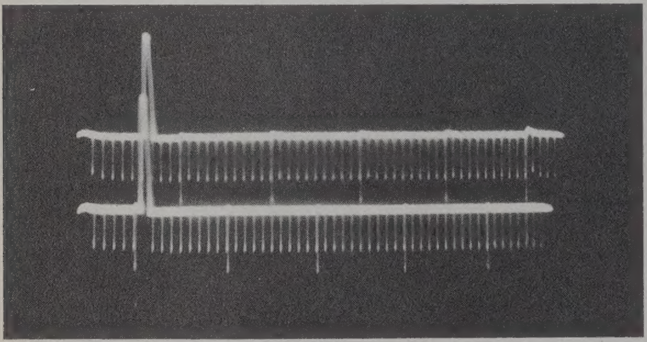

Figure 3-17—Oscillogram, Sweep Speed No. 2, Pulses Properly Aligned

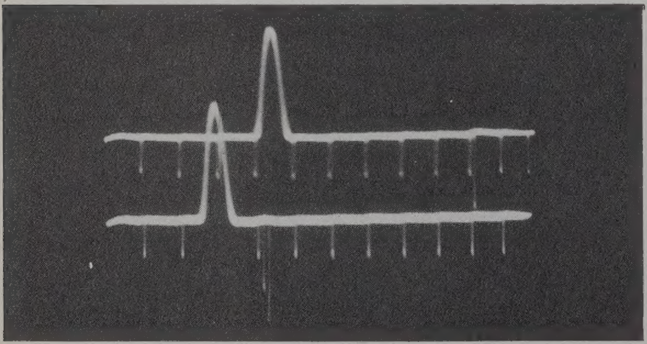

Figure 3-18—Oscillogram, Sweep Speed No. 3, Before Aligning Pulses

e. With the COURSE DELAY control, move the bottom pedestal over until it is under the SLAVE pulse as shown in Fig. 3-15. Set the control midway between the points where the pedestal jumps 500 microseconds either way.

f. Turn the SWEEP SPEED to No. 2. The pedestals are now enlarged to the entire screen width, and the actual shape of the pulses can be seen, as shown in Fig. 3-16.

g. Move the FINE DELAY dial until the bottom pulse signal is approximately below the top one. If the FINE DELAY runs against the stop at either end, turn the COARSE DELAY in that same direction until the pulse jumps 500 microseconds and set the COARSE DELAY in the middle of the stable range. If the pulses are drifting slowly across the screen, adjust the FREQUENCY control to minimize the drift. Now with the LEFT-RIGHT control, run the pulses to the left of the screen until they are within the first 500 microsecond interval, as shown in Fig. 3-17.

h. Turn SWEEP SPEED to position 3. This enlarges the left portion of the number 2 sweep to the entire screen width, as shown in Fig. 3-18. Again shift the pulses to the left portion of the screen with the LEFT-RIGHT control to within the first three 50 microsecond intervals.

i. Turn the SWEEP SPEED to position number 4, which further magnifies the left portion of the number 3 sweep, as shown in Fig. 3-19. Now readjust the FINE DELAY, if necessary, to place the bottom pulse approximately beneath the top one; and if necessary adjust the FREQUENCY to minimize drifting of the pulses.

j. Throw the SWEEP SPEED switch to position 5. This eliminates the trace separation, as shown in Fig. 3-20.

k. Adjust the GAIN and BALANCE controls until the two pulses are the same amplitude and about 1½ inches high. Then adjust the FINE DELAY control until the *left* edges of the pulses are superimposed from the bottom to the top, as shown in Fig. 3-21.

Note

Do not increase the gain to such an extent that the tops of the pulses begin to flatten or distort, as this will produce an error in the result. Do not pay any attention to the right sides of the pulses. After the pulses are matched, do not move the DELAY knobs until the time difference has been read, as described below.

l. Throw the RECEIVER switch OFF and SWEEP SPEED to position 4. From one of the downward projecting 50 microsecond markers on the bottom trace, start counting to the right to a point beneath the next 50 microseconds marker on the top trace. Interpolate the reading between the small upward pointing 10 microsecond markers. In Fig. 3-22, the reading is 10 plus 10 plus 4 equals 24. If there is a 500 or a 2500 microsecond marker on the lower trace, do not attempt to use the 50 microsecond interval containing that marker, but use another interval.

m. Turn the SWEEP SPEED to position 3. Start counting at the long 500 microsecond marker on the bottom trace which is to the left of the 500 marker on the top trace. Count the 50 marks to the right until underneath the 500 microsecond marker on the top trace. This gives the reading to the nearest multiple of 5 microseconds. In Fig. 3-23, it is 4 times 50 equals 200. Neglect any 2500 markers which may appear on the lower trace.

n. Turn the SWEEP SPEED to position 1 (skipping position 2). This gives the reading in the nearest multiples of 500 microseconds. Count the number of 500 microsecond markers from the first long 2500 microsecond mark on the bottom trace to the left edge of the bottom pedestal. The 2500 microsecond markers facilitate the counting. In Fig. 3-24, there are 9 marks—nine times 50 equals 4500. The total reading is then 4500 plus 200 plus 24 or 4724.

o. Turn the GAIN up, center the BALANCE, and set the CHANNEL, PRR, and STATION switches to secure a reading on another pair of stations. (Usually the other pair used will operate on the same CHANNEL and PRR, and it will be necessary only to change the STATION switch.)

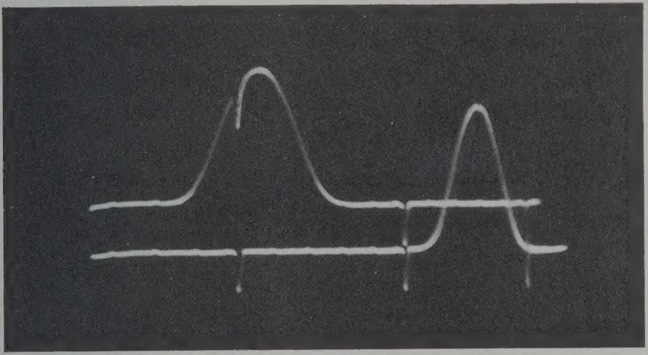

Figure 3-19—Oscillogram, Sweep Speed No. 4, Before Aligning Pulses

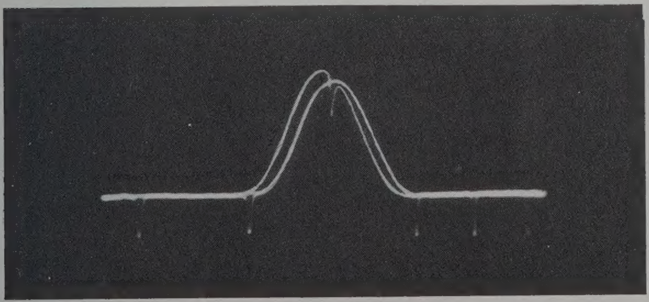

Figure 3-20—Oscillogram, Sweep Speed No. 5, Before Aligning Pulses

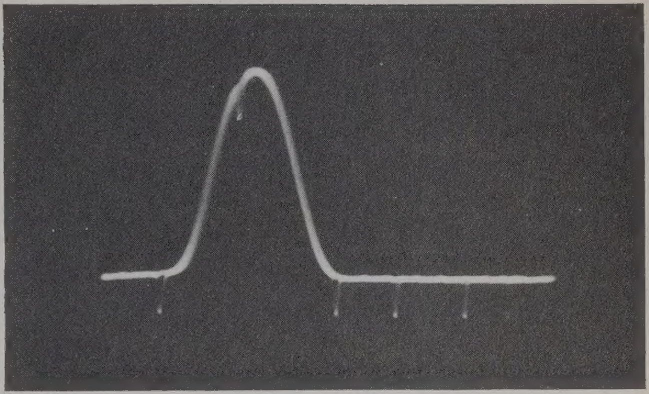

Figure 3-21—Oscillogram, Sweep Speed No. 5, Pulses Property Balanced and Aligned

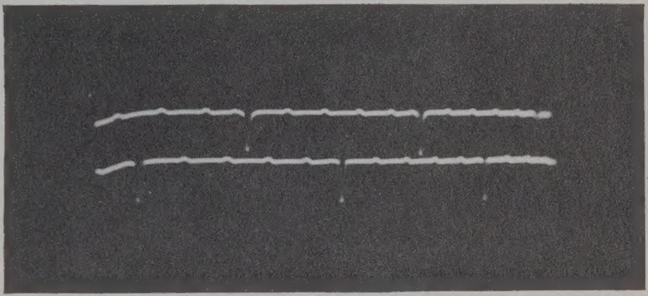

Figure 3-22—Oscillogram, Sweep Speed No. 4, Reading: 24

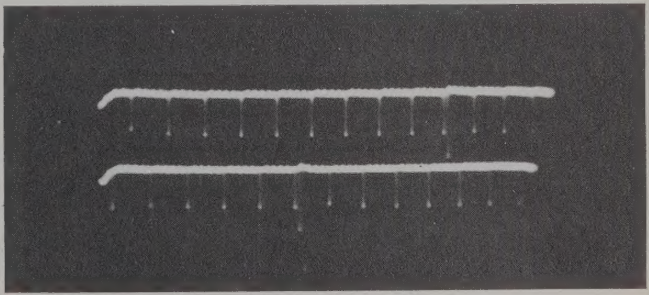

Figure 3-23—Oscillogram, Sweep Speed No. 3, Reading: 200

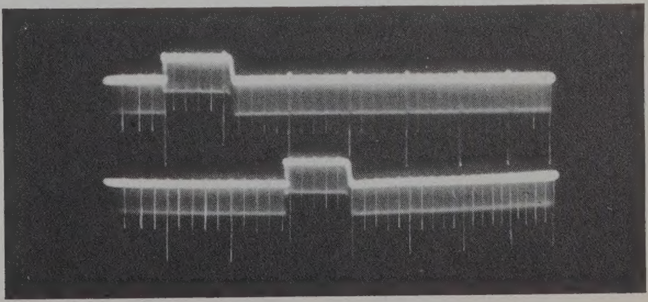

Figure 3-24—Oscillogram, Sweep Speed No. 1, Reading: 4500

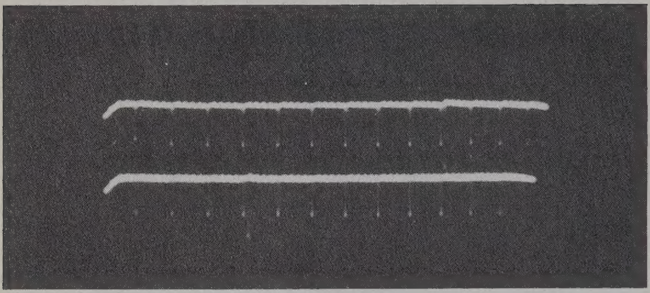

Figure 3-25—Oscillogram, Sweep Speed No. 3, Reading: 300

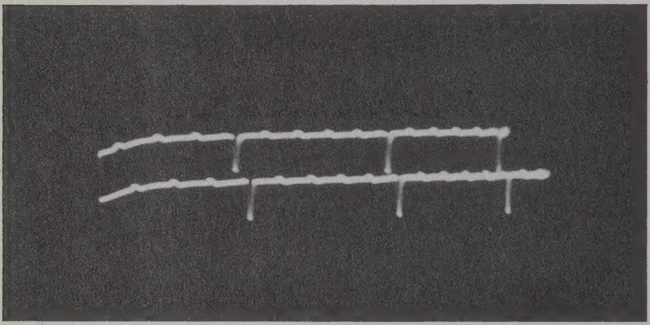

Figure 3-26—Oscillogram, Sweep Speed No. 4, Reading: 47

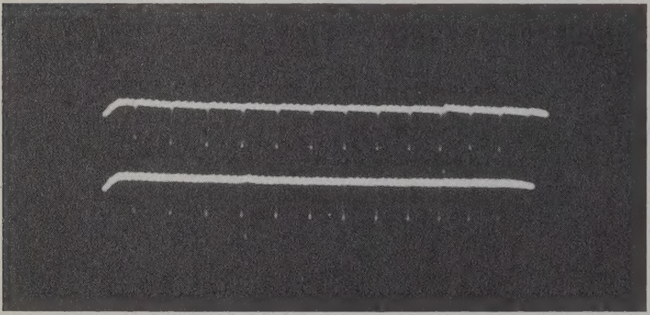

Figure 3-27—Oscillogram, Sweep Speed No. 3, Reading: 300

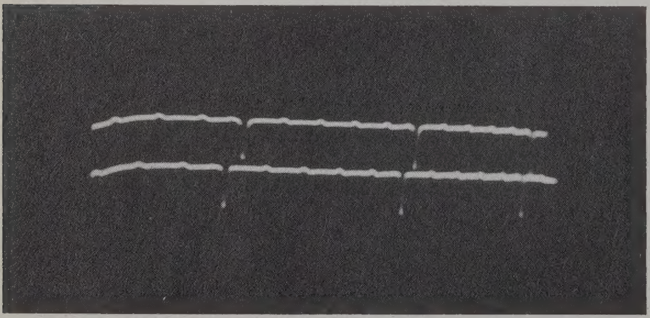

Figure 3-28—Oscillogram, Sweep Speed No. 4, Reading: 04

4. IMPORTANT NOTES ON OPERATION.

a. Under actual operating conditions, multiple pulses may be received at some times. In addition, all signals must be identified as ground waves or sky waves at all times; consult the LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278). In actual operation, an additional step should be incorporated between steps 8 and 9 above. The pulses should be first run to the right on the number 2 sweep and the gain turned up to look for weak pulses to the left of the easily visible ones ebfore aligning the desired pulses, running them to the left and proceeding to the number 3 sweep.

b. If sky waves, instead of ground waves, are being matched, it may be necessary to use the BALANCE and FINE DELAY simultaneously to get a match as in step 11 above, consult the LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278), for details of matching under such conditions.

c. When the reading is in the vicinity of an exact multiple of 50 microseconds, or of an exact multiple of 500 microseconds, special care must be taken to avoid errors of 50 or 500 microseconds in the reading. The slight inherent displacement of 50 and 500 microsecond markers increases the difficulty, and it can be minimized by considering the 500 microsecond markers as "tags" which indicate that the 5 microsecond marker just a few microseconds to the left should be considered as a 500 microsecond marker also.

CASE 1: AMBIGUITY AS TO PROPER MULTIPLE OF 50 MICROSECONDS.

Case 1 errors will be eliminated if the reading on the number 3 SWEEP SPEED is considered as indicating roughly the reading to the nearest 50 microseconds, and rely on the interpolated reading of the number 4 sweep SPEED to determine whether the reading is actually more or less.

(1) Fig. 3-25 would indicate that the reading is 6 x 50 or 300 microseconds, plus some small amount.

(2) However, switching to number 4 SWEEP SPEED (Fig. 3-26) clearly shows that the reading is slightly less than 50 or about 47 microseconds. Referring back to Fig. 3-25 above, it is obvious that the exact reading must be 297.

(3) In Fig. 3-27, the reading on the number 3 SWEEP SPEED is very close to 6 x 50 equals 300. But remembering the previous case, the question comes up as to whether it is actually a little more or less than 300.

(4) Switching to the number 4 SWEEP SPEED produces the picture in Fig. 3-28. The reading is 4 microsceonds and shows that the true reading on the No. 3 SWEEP SPEED is actually over 300 and therefore is 304.

CASE 2: AMBIGUITY AS TO PROPER MULTIPLE OF 500 MICROSECONDS.

Case 2 is similar to Case 1 except the ambiguity involves multiples of 500 microseconds. The procedure for resolving any doubts is also similar.

(1) On the number 1 SWEEP SPEED, we have a picture as shown in Fig. 3-29. It looks like 500 x 7 or 3500 but it is not clear at this point whether the reading is something over or under 3500.

(2) Switching to the number 3 SWEEP SPEED produces a pattern like Fig. 3-30. Our problem has not been solved for the reading might be less than 500 or more than 000.

(3 But switching to the number 4 SWEEP SPEED resolves the ambiguity. In Fig. 3-31 the reading is clearly under 50; 46 to be exact.

This means that the reading on the number 3 FAST SPEED shown above is actually slightly under 500 or 450 + 46 = 496, to be exact. We then conclude the reading on the number 1 SWEEP SPEED was slightly less than 3500 or 3496 to be exact.

(4) Considering an example where the actual reading is slightly more than 3500. The picture of the number 1 SWEEP SPEED, Fig. 3-32, looks like roughly 3500 but it could be slightly more or less than this. Switching to number 3 SWEEP SPEED, Fig. 3-33, still leaves doubt. But examining the pattern in the number 4 SWEEP SPEED, Fig. 3-34, verifies that the reading is actually slightly over 000 in the number 3 SWEEP SPEED (004 to be exact). Therefore, the final reading is 3504.

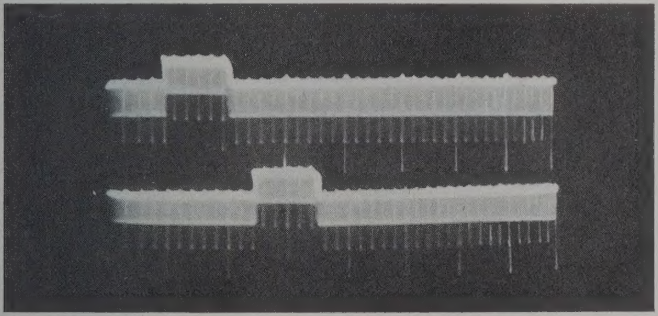

Figure 3-29—Oscillogram, Sweep Speed No. 1, Reading: 3500

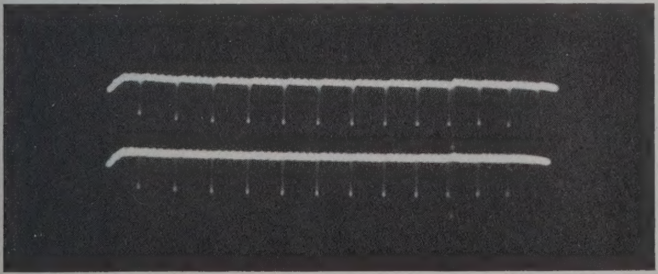

Figure 3-30—Oscillogram, Sweep Speed No. 3, Reading: 500

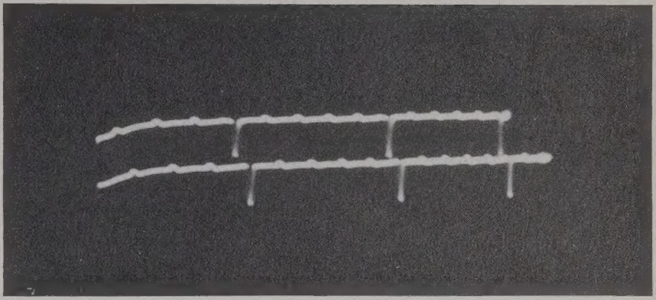

Figure 3-31—Oscillogram, Sweep Speed No. 4, Reading: 46

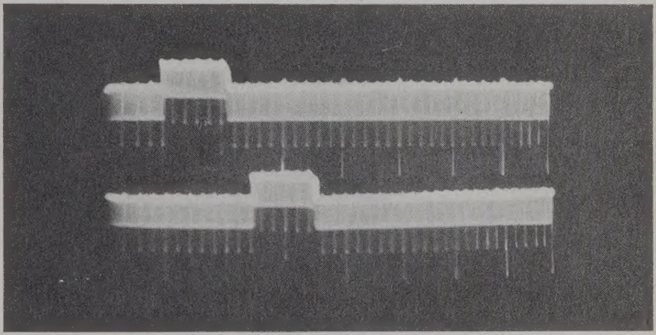

Figure 3-32—Oscillogram, Sweep Speed No. 1, Reading: 3500

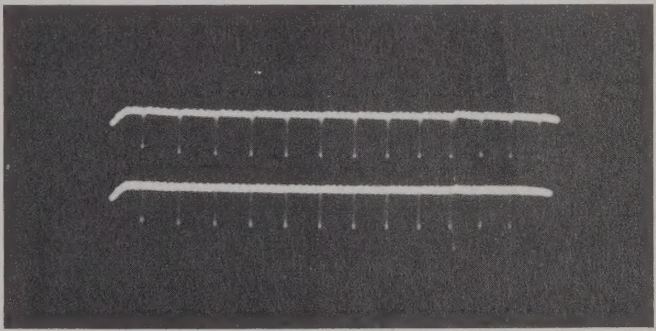

Figure 3-33—Oscillogram, Sweep Speed No. 3, Reading: 500

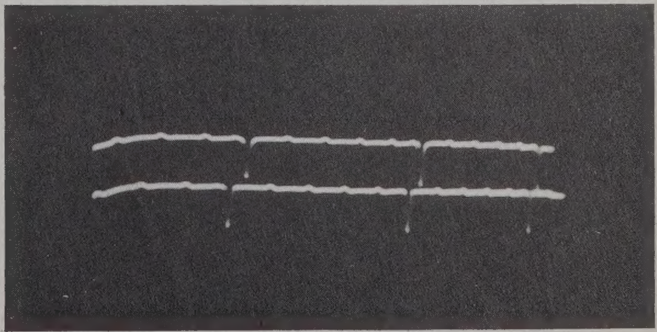

Figure 3-34—Oscillogram, Sweep Speed No. 4, Reading: 04

d. In interpolating unit microseconds between 10's, be careful to interpolate from the peak of the 10 marker, not the base. Where the reading is between 40 and 50, or between 0 and 10, be careful to interpolate from the tip of the 50 microsecond marker and not from the base. Failure to use care in interpolating may result in errors of several microseconds in the reading. Also, do not be confused by 500 or 2500 microsecond markers on the lower trace on the number 4 SWEEP SPEED, or by 2500 microsecond markers on the number 3 SWEEP SPEED.

e. The time of a reading as indicated by the operator's watch, should be recorded at the time of the signal match (step 11 above) before continuing with the marker reading procedure (steps 12, 13 and 14).

f. The gain and balance circuits of the receiver were designed to handle the range of signal strengths encountered under the majority of operating conditions. However, when relatively very near one transmitting station of a pair and very distant from the other station, the receiver circuits may overload and distort the shape of the stronger pulse in a manner similar to Fig. 3-35. This distortion is not to be confused with the top-flattening that occurs in normal operation when the amplitude of a pulse is made too great, as shown in Fig. 3-36. It will noted in Fig. 3-35 that the distortion occurs in the region of the peak and right portions of the pulse. The result is that the pulse is made considerably sharper than normal, and *the peak is apparently shifted to the left.* If the distortion is not noticed and the left edges of the pulses are matched in the conventional manner, *readings will be several microseconds high when near the master station and several microseconds low when near the slave station.*

The effect is greatest near the baseline extensions, for here the difference in distance to the two stations is greatest, and here a small error in microseconds makes a large error in miles. Since the distortion is a function both of the relative strength of the two signals and the absolute strength of the strongest signal, it will be most noticeable when the baseline length is great, or where intervening land additionally attenuates the signal from the more distant station. Where the baseline is 300 miles long, the distortion may become noticeable when near the baseline extensions within 50 miles of a station.

If it is suspected that overloading and distortion are occuring, check by setting the BALANCE control to center and adjusting the GAIN control until the stronger pulse can be seen. Then, with the indicator switched to the fastest sweep (SWEEP SPEED 4), simultaneously increase the GAIN and turn the BALANCE until the weaker pulse is seen, and in the meantime watch the stronger signal for signs of distortion.

Accuracy of pulse matching under conditions of distortion may be improved by the following technique:

(1) Where possible (at fixed monitor stations only, not aboard ship), try temporarily decreasing antenna length to see if distortion is decreased.

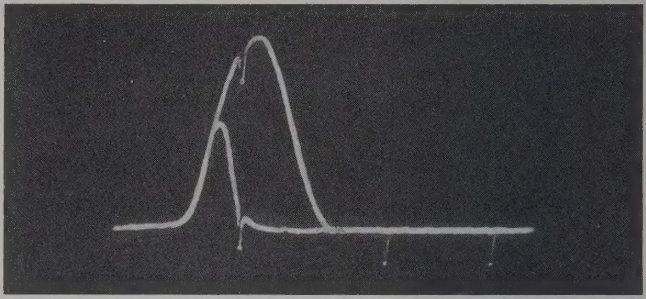

Figure 3-35—Oscillogram, Sweep Speed No. 4, Pulse Distortion

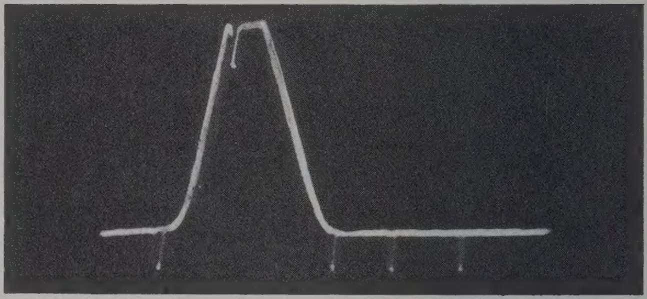

Figure 3-36—Oscillogram, Sweep Speed No. 4, Pulse Distortion

(2) When a distorted pulse is seen, try turning the GAIN down. Sometimes this will cause the pulse height to increase and then decrease, thus producing a normal pulse.

(3) If the distortion is eliminated by using less than normal gain (pulses about one-half inch high), use this pulse height, rather than the normal one and one-half inch pulse height.

(4) If a normal pulse cannot be secured by any of the above means, match the imaginary normal pulse, rather than the actual pulse, by disregarding relative pulse heights and matching the shapes of the left edges.

The ability of the equipment to handle strong and greatly unbalanced signals without distortion is greatly improved by Change No. 5.

g. The FILTER will help reduce certain types of interference, particularly radio telegraph or radio telephone, when it is switched IN. For details on interference, see the section on INTERFERENCE and JAMMING in the LORAN HANDBOOK FOR SHIPBOARD OPERATORS (SHIPS 278).

5. SIMPLIFIED EMERGENCY ALIGNMENT PROCEDURE FOR OPERATORS.

The actual alignment procedure for the equipment (not to be confused with the OPERATING ALIGNMENT CHECK, previously described on page 3-2) is, strictly speaking, a job for a radio technician. However, the radio technician may not be available at the time that the Loran equipment alignment becomes defective. Thus, as an emergency procedure, a SIMPLIFIED ALIGNMENT PROCEDURE is given here which covers adjustments accessible from the front panel and may be made by the operator.

WARNING

> HIGH VOLTAGES ARE PRESENT INSIDE THE CABINET. ALL INTERNAL ADJUSTMENTS, AS DESCRIBED ON PAGE 5-3, SHOULD BE MADE ONLY BY A RADIO TECHNICIAN.

a. On DAS equipments (before installation of the PRR switch) the HOR. CENT. and VERT. CENT. screwdriver controls are located on the front panel. On DAS-a and DAS-2 equipments, these controls have been moved to the interior of the cabinet, at the upper left-hand front corner of the indicator unit. These controls change the position of the entire pattern on the screen. With the SWEEP SPEED control on position 2, adjust HOR. CENT. so that the pattern is in the center of the screen in a horizontal direction. If the HOR. CENT. control is turned too far, the sweep may become non-uniform at the ends (markers crowded together). This condition can be avoided because there is sufficient range of control before this region is reached. Then turn the SWEEP SPEED switch through all positions to check the centering on all sweeps. If some are off to one side, a compromise setting of HOR. CENT. should be made. The VERT. CENT. control should then be adjusted so that approximately $1\frac{3}{4}''$ of pulse height on top of the traces can be tolerated without going off the screen at the top.

b. The quality of the pattern on the cathode ray tube screen is adjusted by means of the INTENSITY, FOCUS and ASTIGMATISM controls. Set SWEEP SPEED to position 1, and adjust INTENSITY and FOCUS simultaneously for a sharp, clear pattern. Various settings of the ASTIGMATISM control should be tried to secure the best over-all focus in all portions of the pattern. The final pattern should have very clear and distinct time markers showing.

c. Adjustment "C1" controls the ratio of the First Counter, and determines the number of 10 microsecond intervals between 50 microsecond markers, as seen on SWEEP SPEED 4 with RECEIVER control OFF. This control should be set in the center of the range where the correct pattern of five 10 microsecond intervals between 50 microsecond markers is obtained (see Fig. 3-4). Then the alignment of 10 and 50 microsecond markers should be checked (see page 3-3, paragraph *d*, of OPERATING ALIGNMENT CHECK).

d. Adjustment "C2" controls the ratio of the Second Counter, and determines the number of steps seen on SWEEP SPEED 3, with RECEIVER control on CAL. 1, and STATION at 0. This control should be set in the center of the range where the correct pattern of 10 steps is obtained (See Fig. 3-7).

e. Adjustment "C3" controls the ratio of the Third Counter, and determines the number of steps in each group, as seen on SWEEP SPEED 1, with RECEIVER switch on CAL. 2. This control should be set in the center of the range where the correct pattern of five steps in each group (except four steps in the first group) is obtained. (See Fig. 3-10, 11.)

f. Models DAS and DAS-a have a control "C4" and Model DAS-2 has a corresponding control "C4-A." In the DAS, control "C4" is in the circuit at all times. In the DAS-a and DAS-2 the control is in the circuit when the PRR switch is set to L position. This control determines the dividing ratio of the Fourth Counter, which determines the number of groups of steps as seen on SWEEP SPEED 1, with the RECEIVER control on CAL. 2. With the PRR switch, if any, set to L, this control should be set to the center of the stable range where the correct pattern of eight groups of steps is obtained. (See Fig. 3-10.)

g. In Model DAS-a and DAS-2, control "C4B" determines the dividing ratio of the Fourth Counter when the PRR switch is set to H. This determines the number of groups of steps seen with the same SWEEP SPEED and RECEIVER switch settings as above. The control should be set to the center of the stable range where the correct pattern of six groups of steps is obtained. (See Fig. 3-11.)

Note

> In DAS equipments the range of adjustment of "C4" is sufficient to allow adjustment to the PRR switch H position pattern of six groups of steps, if it is desired to receive stations operating at the H position of PRR, and no switch is installed.

h. If actual signals are available, turn up GAIN and adjust STATION and PRR to stop a pulse; then check to see if the LEFT-RIGHT control drifts the pulse at the same speed LEFT or RIGHT on SWEEP SPEED 1. If it does not, re-adjust adjustment "C1" very *slightly* to produce such action. Then check (but do not bother to readjust unless incorrect) through steps *c, d, e, f* and *g.* If the alignment of 10 and 50 microsecond markers is not correct, it may be possible to find a compromise setting of "C1" which will produce correct marker alignment and still provide the correct LEFT-RIGHT action on the SWEEP SPEED 1. If not, there is need for internal adjustment of the indicator.

i. The range of the FINE DELAY control is adjusted by the HI and LO screwdriver controls adjacent to and slightly above the knob, as follows: Set the RECEIVER switch to OFF, the SWEEP SPEED switch to position 3, and the FINE DELAY knob fully counterclockwise. Turn the LO control counterclockwise until the lower or "B" trace disappears, then turn it clockwise until the trace reappears, and continue turning until two 50 microsecond markers on the lower trace have moved past the

500 marker on the upper trace, and stop turning on the third marker. Then slowly turn the FINE DELAY knob fully clockwise, and 12 additional 50 microsecond markers on the lower trace should move past the 500 microsecond marker on the upper trace. If more than 13 or less than 11 markers move past, readjust the HI adjustment until the correct number of 12 do move past. This gives the FINE DELAY knob a range of about 650 microseconds; there is nothing critical about the adjustment of HI and LO, as long as a total range of at least 500 microseconds is covered, however, a range of about 650 microseconds makes for more convenient operation.

j. The range of the COARSE DELAY control is adjusted by the HI and LO screwdriver controls adjacent to the knob, as follows: Set the SWEEP SPEED to position 1, and the COARSE and FINE DELAY knobs fully counterclockwise. The left edge of the lower pedestal should then be at the first 2500 microsecond marker, approximately. If it is not, adjust LO until it is as near as possible. Then turn the COARSE DELAY fully clockwise, and the pedestal should move over to slightly past the fifth 2500 microsecond marker. If it does not, adjust HI until it does.

k. The positioning adjustment for the top pedestal is located inside the cabinet, and therefore should be adjusted by a radio technician. However, if the top pedestal is displaced from its correct position at the first 2500 microsecond marker, it is still possible to make a correct reading, provided the pedestal is steady, and not jittering. Just count the 500 microsecond markers on the bottom trace as usual, but start counting at a point just below the left edge of the top pedestal, wherever it is.

l. The adjustments for positions 1 through 7 of the STATION selector switch are located inside the cabinet, and therefore should be adjusted by a radio technician. However, if the correct number of steps, as seen with SWEEP SPEED 3 and RECEIVER switch on CAL 1, are not present for the various positions of the STATION selector switch, the situation can sometimes be remedied by a slight readjustment of "C2" within the range where the correct pattern of ten steps is seen with the STATION selector on 0. Also a slight readjustment of "C4", "C4A" or "C4B", within the range where the correct pattern of eight or six groups of steps is seen with the RECEIVER switch on CAL 2 will sometimes correct the STATION selector switch test patterns. In an emergency, when no radio technician is available, it may still be possible to operate the equipment by disregarding the number on the STATION selector switch and choosing a position which gives the correct number of steps for the specific pulse recurrence rate of the desired stations.

6. SUMMARY OF SWITCH POSITIONS.

a. OPERATING ALIGNMENT CHECK.

Step No. of Operating Alignment Check	RECEIVER Switch Position	SWEEP SPEED Switch Position	Brief of Operations Performed
b	OFF	1	Check position of top pedestal at first 2500 microsecond marker. Check range of COARSE DELAY.
c	OFF	4	Check for five 10-microsecond spaces between 50 microsecond markers.
d	OFF	4 then 5 then 4	Check alignment of 10 microsecond and 50 microsecond markers.
e-f	CAL. 1	3	Check for ten steps with STATION selector switch on 0, and one step less for each advanced position of STATION selector switch. Station switch number plus number of steps equals 10. *Check on both L and H positions of PRR.*
g	OFF	3	Check that range of FINE DELAY is at least 500 microseconds.
h-i	CAL. 2	1	Check for eight groups of five steps on L position of PRR and six groups of five steps on H position of PRR. (First group contains only four steps).

b. OPERATION: MAKING A READING.

Step No. of Detailed Operation Procedure	RECEIVER Switch Position	SWEEP SPEED Switch Position	Brief of Operations Performed
a-e	ON	1	Place pulses on pedestals.
f-g	ON	2	Align pulses, drift to right, raise gain and look for weak pulses, identify ground and sky waves,* align desired pulses and drift to left.
h	ON	3	Drift pulses to left.
i	ON	4	Align pulses more closely.
j-k	ON	5	Accurate alignment of left edges of pulses.
l	OFF	4	Interpolate units and read tens.
m	OFF	3	Read fifties.
n	OFF	1	Read five-hundreds, and add to readings on 4 and 3 SWEEP SPEEDS to get total reading.

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* Ground and sky waves can be identified on other fast sweeps, also.

The above tables will prove a good memory guide when making a check of the equipment or when taking a reading.

IV. THEORY OF OPERATION OF EQUIPMENT

1. GENERAL FUNCTIONS OF CIRCUITS.

The principles of operation of the Loran System are described in detail in the Loran Handbook for Shipboard Operators (Ships 278); that section of the Handbook, as well as the OPERATION section of this instruction book, should be studied before attempting to understand the theory of operation of this equipment.

Basically, the purpose of the equipment is to measure the difference in time of arrival of radio signals from a pair of fixed Loran transmitting stations. The signals are pulses approximately 40 microseconds long, transmitted at a definite recurrence rate. The signals from the two stations of a pair occur at the same recurrence rate, and are rigidly synchronized, but are so staggered that they are received during alternate halves of the recurrence interval. For identification of different station pairs, various recurrence intervals in the vicinity of 40,000 microseconds (25 pulses per second) or 30,000 microseconds (33-1/3 pulses per second) are used. Also several different radio frequency channels are used. The equipment, then, must include a receiver for reception of the signals, time standards as a basis for measurements, and a cathode ray oscilloscope with sweep circuits for visually observing the signals and time standards and determining the difference in time of arrival of the signals.

The simplified Block Diagram, Fig. 4-1, shows the basic circuits required. The standard frequency generator, operating at 100 kc/s, forms the starting point. This frequency is reduced by the frequency dividing circuits to twice the pulse recurrence rate of the received pulses. The dividing circuits include a means for producing various basic and specific pulse rates which correspond to the recurrence rates of the Loran signals. The Time Corrector circuit compensates for a timing irregularity introduced by the dividing circuits when the specific recurrence rate (STATION switch setting) is other than zero, and on the slow sweep (SWEEP SPEED 1) triggers the sweep generator, also at twice the recurrence rate of the received signals. The Time Corrector circuit also triggers the Square Wave Generator, which produces a square wave with a recurrence period equal to that of the received pulses; that is, the square wave is positive during one trace of the slow sweep and negative during the next. This square wave is applied, through mixer circuits, to the vertical plates of the cathode ray Oscilloscope, and vertically separates alternate sweeps to provide the upper and lower traces. Alternate half cycles of the square wave are also used to trigger the A and B Pedestal Delay circuits, and these in turn trigger the Pedestal Generator. The pedestals are applied through mixers to the vertical plates of the Oscilloscope, and appear on the slow sweep. On the fast sweep (SWEEP

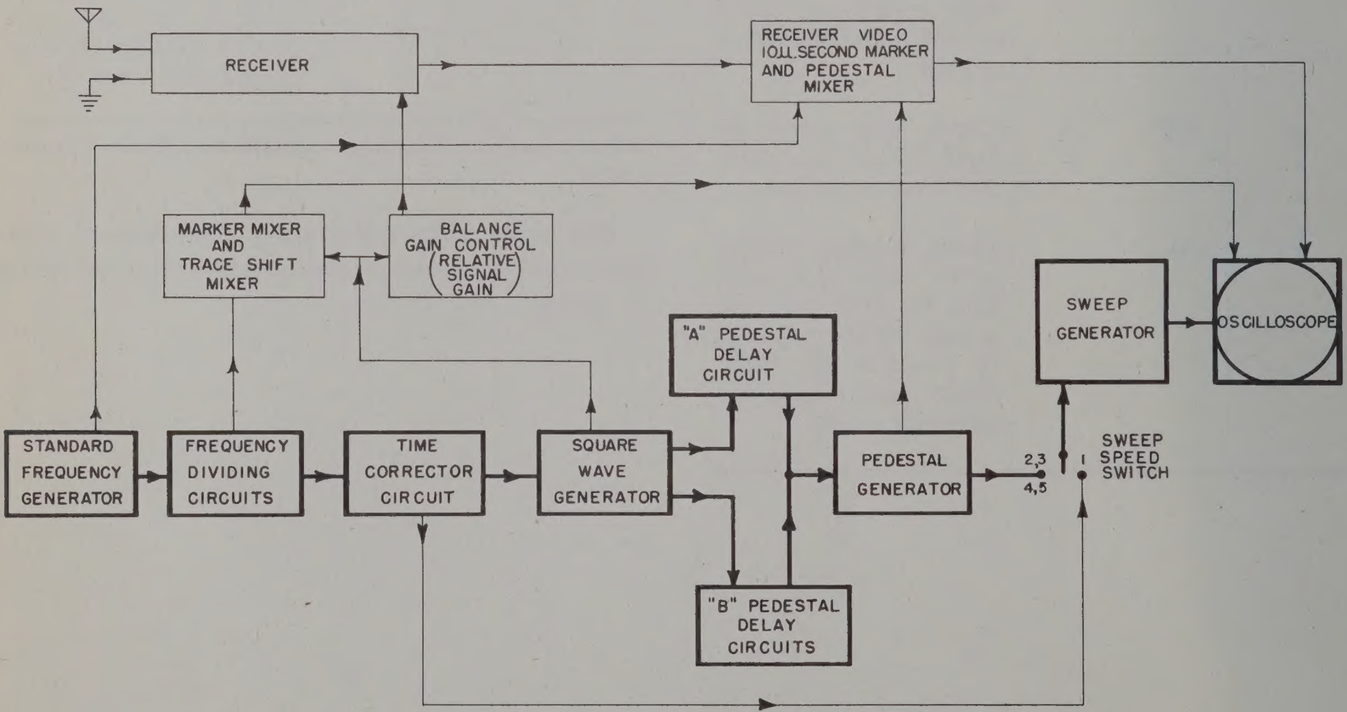

RECEIVER
RECEIVER VIDEO 10µ SECOND MARKER AND PEDESTAL MIXER
MARKER MIXER AND TRACE SHIFT MIXER
BALANCE GAIN CONTROL (RELATIVE SIGNAL GAIN)
SWEEP GENERATOR
OSCILLOSCOPE
"A" PEDESTAL DELAY CIRCUIT
STANDARD FREQUENCY GENERATOR
FREQUENCY DIVIDING CIRCUITS
TIME CORRECTOR CIRCUIT
SQUARE WAVE GENERATOR
PEDESTAL GENERATOR
2,3
4,5
1
SWEEP SPEED SWITCH
"B" PEDESTAL DELAY CIRCUITS

Figure 4-1—Receiver-Indicator Unit, Simplified Block Diagram

SPEEDS 2 through 5), the Sweep Generator is triggered by the Pedestal Generator and produces sweeps which start at the same time as the pedestals.

The 10 microsecond time markers are derived from the standard frequency generator, and the 50, 500 and 2500 microsecond markers are derived from the frequency dividing circuits. These markers are applied also to the vertical plates of the oscilloscope. The receiver is conventional except that it has wide band-pass characteristics and has special BALANCE gain circuits. The Balance Gain Circuits are driven by the Square Wave Generator in such a way that the Receiver gain may be reduced during the time of either the upper or lower trace.

a. DISCUSSION OF BLOCK DIAGRAM.

The following is a brief discussion of the Block Diagram, preparatory to the more detailed discussion of the circuits. Reference is made to the diagram, Fig. 7-20 at the rear of the book, and the accompanying waveforms, Fig. 7-19.

The fundamental time standard of the equipment is the Crystal Oscillator, which is shown in the left-center of the block diagram. The oscillator frequency is 100 kc. This frequency is a convenient low frequency for the operation of a crystal and provides direct timing for 10 microsecond markers. This is also a convenient frequency for division down to the pulse recurrence rate of approximately 25 or approximately 33-1/3 pulses per second. The Crystal Buffer stage also operates at 100 kc and serves to isolate the crystal circuit from the counters and the Ten Microsecond Marker circuit.

The First Counter produces one output pulse for every five input cycles, and therefore produces pulses at 50 microsecond intervals. The Second Counter produces one output pulse for every ten input pulses, therefore its output pulses are nominally at 500 microsecond intervals. The Third Counter produces one output pulse for every five input pulses, therefore, its output pulses are nominally spaced at 2500 microsecond intervals. The Fourth Counter produces one output pulse for every eight input pulses for the L (25 per second) basic pulse recurrences rate, and one output pulse for every six input pulses for the H (33-1/3 per second) basic rate. The counter, then, nominally puts out one pulse every 20,000 or every 15,000 microseconds, corresponding to the received pulse cycle. This forms the basis for the sweep recurrence rates. Since there are two sweeps (the upper and the lower) during the recurrence interval of the received pulses, the sweep rates are 50 or 66-2/3 per second.

Some of the output from the last Counter may be fed back into the Second Counter through the STATION switch and Step Feedback circuit. The amount of feedback is varied so that each time the Fourth Counter fires, the following Second Counter output interval (nominally 500 microseconds) is reduced by a predetermined number of 50 microsecond intervals. This number is variable from zero to seven, corresponding to the numbers on the STATION switch. Thus, immediately after a Fourth Counter output pulse, the Second Counter may produce one "short" interval followed by 39 (or 29, depending upon the PRR setting) normal 500 microsecond intervals. The cumulative effect along the counter chain is to reduce the interval between Fourth Counter output pulses, and to increase the sweep recurrence rate correspondingly.

The output pulses of the Second Counter are used for timing the Coarse Delay circuit, and the output pulses from the Third Counter are used for timing the Fixed Delay circuit. As will be explained later, they locate the ends of the delay periods. The purpose of the Time Corrector circuit is to "take up" the short "500" microsecond interval referred to above and form a timing basis for the Delay circuits which is free from the variable spacing of the counter pulses and, therefore, will not lead to instability in the Delay circuits.

The Time Corrector circuit fires each time the Fourth Counter fires; it makes the time correction explained above and then fires the Eccles-Jordan Square Wave Generator. The plate potential of the Eccles-Jordan Generator changes value each time it is triggered, thus it takes two trigger pulses to make one complete square wave cycle, dividing (as a secondary function of this stage) the 50 (or 66-2/3) cps. output frequency of the Fourth Counter by two, with a resultant frequency of 25 (or 33-1/3) cps.

The Eccles-Jordon Square Wave Generator produces two output voltage waves. When one wave is positive the other is negative, and the two alternate nominally at a 25 (or 33-1/3) cps. rate, staying at one potential for one-half the recurrence interval, then changing. This square wave output is applied to the vertical plates of the cathode ray tube to produce trace separation; it is used to supply the Balance Gain Control circuit with square waves to vary the receiver gain, and it is used to trigger the Coarse Delay and Fixed Delay Multivibrators. These two delay circuits are alternately tripped, the fixed delay multivibrator being fired at the start of the upper trace while the Coarse Delay Multivibrator is tripped from the opposite phase of the Square Wave Generator, or the start of the lower trace. The end of the Fixed Delay is locked on a Third Counter output pulse, so it occurs 2000 microseconds after the start of the sweep; the end of the Coarse Delay is locked on 500 microsecond output pulses from the Second Counter. The Coarse Delay Multivibrator trips the Fine Delay Multivibrator which acts as a vernier adjustment (by adding to the Coarse Delay time) and makes it possible to introduce any desired total delay after the start of the B trace. The ends of the delay times from the Fixed and Fine Delay Multivibrators are used to trigger the Pedestal Generator; thus the position of the pedestal on the A trace is established by the Fixed Delay Multivibrator, and the pedestal on the B trace by the Coarse and Fine Delay multivibrators. The two pedestals so generated are applied to the Cathode Ray Tube through the Receiver, Ten Microsecond Marker, Pedestal Mixer stage, and the RECEIVER switch.

The Fixed Delay multivibrator has two output waves which are simultaneous positive and negative blocks of voltage. Each of these is fed to the LEFT-RIGHT control which is used to move the pulses to the left or right on the cathode ray tube screen. With the switch in one position the negative wave function is fed into the circuit of the First Counter which causes it to count more than 5 before it fires, and the output frequency is lowered. This forces the sweep out of synchronism with the received pulses, and the pulses move slowly across the trace. With the LEFT-RIGHT control in the opposite direction, the positive waves are introduced into the First Counter circuit which makes it count less than five and the output frequency is increased. This makes the pulses move across the traces in the other direction. The switch is normally in the center and introduces no waveform into the counter circuit.

Some of the Pedestal Generator output is fed through the RECEIVER Switch and SWEEP SPEED Switch into the Pedestal Buffer. This stage converts the Pedestal to low impedance and its output is used to drive the Blanking Restorer and Sweep Generator. The Blanking Restorer allows the bias of the cathode ray tube to be lowered during the time it is desired to have the sweep visible and applies a high negative bias during the remaining "blanked time."

The slow sweep speed is generated by turning off the Sweep Generator tube during the "short" Second Counter output interval discussed above, and allowing the sweep to start immediately after this is completed. This starting signal is derived from one plate of the Time Corrector Stage and is fed into the Sweep Generator through the RECEIVER Switch, SWEEP SPEED Switch, and Pedestal Buffer. The Cathode Ray Tube is blanked off only during the time that this signal is applied to the Sweep Generator.

There are three rates of the fast sweeps, and all are started coincident in time with the start of the pedestals by the application of the output of the Pedestal Generator instead of the Time Corrector as the tripping pulse for the Sweep Generator. The time length of the applied pedestal is equal to the sweep time. Sweeps are sawtooth in shape and cause the electron beam to move from left to right by applying a negative-going sawtooth to the left deflection plate of the cathode ray tube and a positive-going sawtooth wave (which is derived from the sweep amplifier) to the right-hand plate.

The counters are a convenient source for time markers as their periods afford useful and convenient intervals. The shapes of their plate pulses are such that they can be easily converted into markers by clipping off just the top of the waves. This clipping is accomplished in the Marker Mixer which is fed with plate pulses from the First Counter (50 microseconds), Second Counter (500 microseconds) and Third Counter (2500 microseconds). There is, however, a need for smaller divisions than are afforded by the 50 microsecond markers and this is provided for by the 10 microsecond Marker circuit. It is important that these 10 microsecond markers be exactly coincident in time with the 50 microsecond markers and a means to adjust them to coincide is provided in a phase shift network incorporated in the 10 Microsecond Marker stage. The 10 Microsecond Markers are positive-going and are introduced on the upper plate of the cathode ray tube to give an upward deflection of the electron beam. The 50, 500, and 2500 microsecond markers are also positive-going and are introduced through the Marker Mixer and Trace Shift Mixer tubes to the bottom plate of the cathode ray tube to produce a downward deflection of the beam.

The antenna, shown in the upper right-hand corner of diagram, is vertically polarized to afford optimum ground wave response and is made as long as possible to provide the greatest signal response and hence reduce the effects of local noise. As it is often impossible to use a sufficient antenna length, some means must be used to make a shorter length of wire have the same apparent electrical characteristics as the longer wire, and to resonate at the frequency of the incoming signal. A resonant antenna provides much greater signal than a non-resonant antenna, however it should be realized that the amount of signal received from it decreases in proportion to its length.

To tune out the residual reactance of the short antenna, a loading-coil is placed in series with it. This loading-coil can be adjusted to compensate for the variable length and capacity of the antenna. The antenna is terminated into a tap on the RF amplifier grid coil. The entire coil is tuned to resonance and hence a voltage gain is realized in this coil. The r-f stage and antenna input are made to have as great a gain as possible so that the signal applied to the converter is large, and inherent converter noise will be small in comparison.

The converter, working in conjunction with the local oscillator, changes the frequency of the incoming signal from radio frequency to an intermediate frequency by heterodyne action. The output from the converter is fed to the first and second i-f amplifiers where the signal is amplified. The Receiver Gain Control varies the cathode potential and hence the gain of the first four tubes in the receiver. The third i-f amplifier gain is not controlled by the Receiver Gain Control, but is varied at a 15 cycle rate by square waves derived from the Eccles-Jordan Square Wave Generator through the Balance Gain Control. These square waves are synchronous with the pulses under observation and make it possible to vary the relative amplitude of the two pulses by decreasing the gain of the third i-f amplifier while the stronger pulse is being received, and allowing the gain to return to normal while the weaker pulse is being received. The amount that the gain is reduced, and which of the two pulses is attenuated, is determined by the setting of the Balance Gain Control.

The third i-f stage is followed by the demodulator, a diode type which rectifies the intermediate frequency envelope to produce the video signal. The output is negative-going and is amplified by the video amplifier.

The signal appears as a positive wave or pulse in the output of the video amplifier, and is then mixed with ten microsecond markers and the pedestal voltage and applied to the upper vertical deflection plates of the cathode ray tube. When the video signal goes positive, the electron beam is deflected upward. The waveform adjacent to the upper plate of the cathode ray tube (Fig. 7-20) shows the base line; the fine vertical lines which are the 10 microsecond markers, the raised portion of the trace which is the pedestal, and the video signal which appears as a single pulse to the right of the pedestal.

A means of checking the operation of the counters by using the cathode ray tube is provided in the RECEIVER switch in conjunction with two Counter Test isolation tubes. The ten count steps of the Second Counter are visible on CAL. 1 position of the RECEIVER Switch and eight (or six) flights of five steps each are visible on CAL. 2. The five steps in each stair show the count of five in the Third Counter and the eight flights show that the Fourth Counter is counting eight for the 50 cycle rate (or six flights for the 66 2/3 cycle rate).

b. DIFFERENTIATOR (R-C PEAKER)

Several places in the discussion of the Indicator Unit reference will be made to a "differentiator" and "differentiation." To avoid a separate explanation of the function of differentiation each time it occurs, the explanation will be made now, and not repeated in the text.

Consider the circuit, Fig. 4-2 (A), with a battery, a switch, and a load which is not pure resistance. Let time be an independent variable. After two seconds the switch is closed and the voltage "E" begins to build up across the load. This makes "E" a dependent variable, dependent upon time. This voltage, when plotted as a function of time, is represented by the curve in Fig. 4-2 (B) in which the voltage slowly builds up during the third and fourth second intervals. The slope (or deriviative) of the curve is the rate of increase or decrease in voltage during a time interval. From zero to one second the slope is zero volts per second; from one to two seconds it is also zero. From two to three seconds the voltage increases from zero to three volts, and the slope is $\frac{3-0}{3-2}$ or 3 volts per second. During the three to four second interval the voltage increase is from three to six volts and the slope is $\frac{6-3}{4-3}$ or 3 volts per second. During the fifth and sixth seconds, there is no further increase in voltage, and so the deriviative or slope is again zero.

If we now plot the deriviative as a function of time, we can study the rate of change of the voltage, rather than just the voltage. Thus, in Fig. 4-2 (C), when there is no change in voltage across the load there is *zero rate* of change, as from zero to two and four to seven seconds. When there is a change in voltage, however, there is a definite rate of change, or differential, as from two to four seconds.

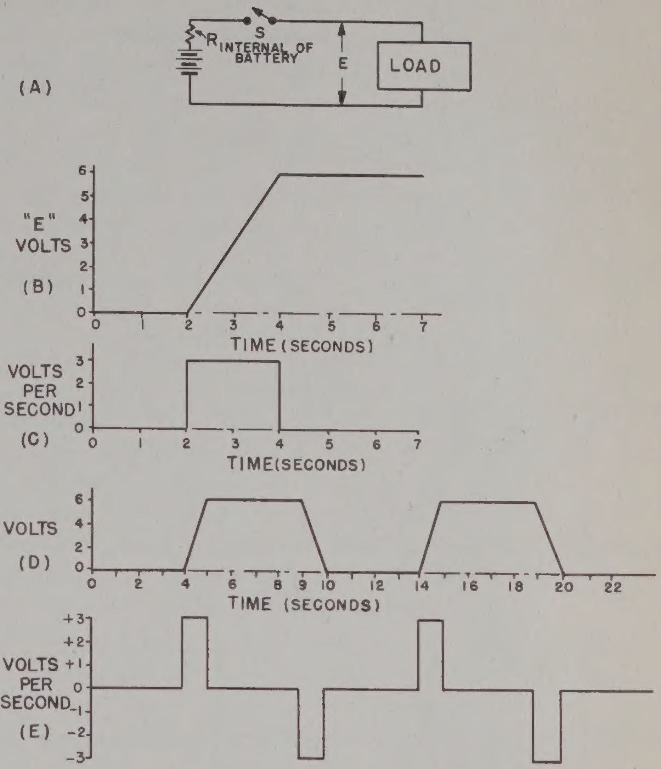


Figure 4-2—Ideal Electrical Differentiation Curves

Now consider the "square" wave of voltage shown in Fig. 4-2 (D). The sloping sides of the "squares" are true representations, because it does take some time, no matter how little, for a voltage to change from zero to a finite value. The slope here, however, is exaggerated to illustrate the point.

The deriviative of this wave is shown in Fig. 4-2 (E). The downward, or negative slope of the curve in the nine to ten second interval gives a negative rate of change, and so each square produces both a positive and a negative differential as shown.

Electrical differentiation is accomplished by a combination of resistance and capacitance. If the voltage represented in the foregoing figures is the voltage across a capacitor, the differential is a representation of the current flowing into it. The basic circuit is shown in Fig. 4-3 (A). Note that this circuit is the familiar plate-to-grid coupling used in audio amplifiers. If the R and C are very large, an ideal square wave passed through this circuit will not have time to completely charge the condenser through the resistor, and the wave will be essentially the same on the output side as it is on the input side (Fig. 4-3B). The current flowing through the resistance into the capacitor produces the output voltage "E" across the terminals.

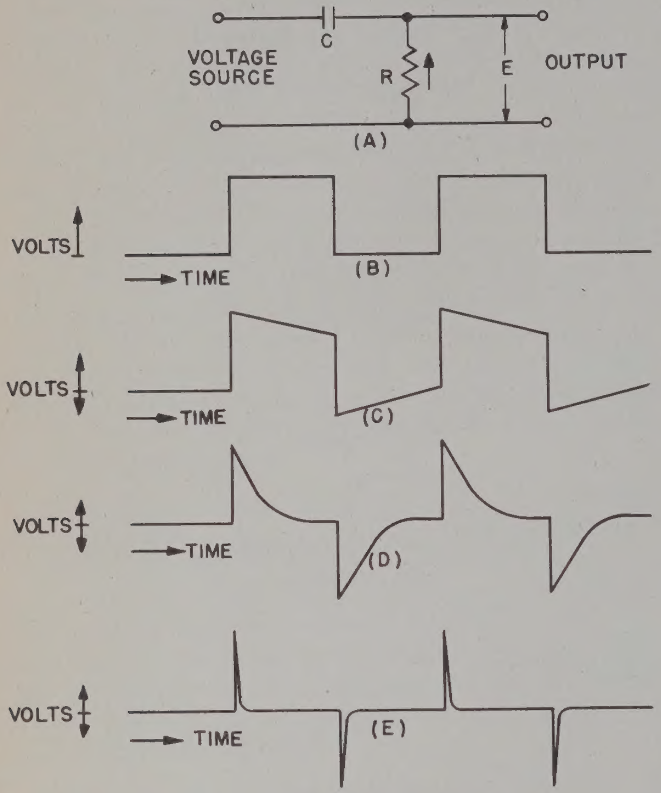


Figure 4-3—Practical Electrical Differentiation Curves

If the R and C are small, the output wave will be as in Fig. 4-3 (D). Note that sufficient time has elapsed for the current through R to completely charge C, both positively and negatively, during each cycle of the square wave. The curvature arises from the exponential charging curve of a capacitor.

Carried to an extreme case with a very small R and C, the resistor charges the output side of the capacitor almost immediately, and a voltage similar to that in Fig. 4-3 (E) is obtained. This is the differentiated square wave in which we are interested.

Because the differentiated wave gives a positive pulse at the beginning, and a negative pulse at the end of each positive going square wave, by selecting which pulse is used, it is possible to trip other circuits at either the beginning or at the end of each square wave. This method is quite generally used in the indicator timing circuits.

Mathematically, differentiation is the process by which a derivative of an algebraic equation or function is obtained. The derivative of a function is the instantaneous rate of change of one variable (dependent element) with respect to another variable (independent element). To represent this graphically, draw the curve of any function as in Fig. 4-4, and the derivative of the function at any point on the curve, such as at X or Y, will be represented by the slope of the tangent to the curve at that point. Thus the greater the rate of change of one variable with respect to the other, the greater will be the slope of the tangent, or derivative. If there is no change in the dependent variable with a change in the independent variable, the slope, or derivative, is zero as at Z, in Fig. 4-4. It is from this mathematical conception that the circuit derived its name.

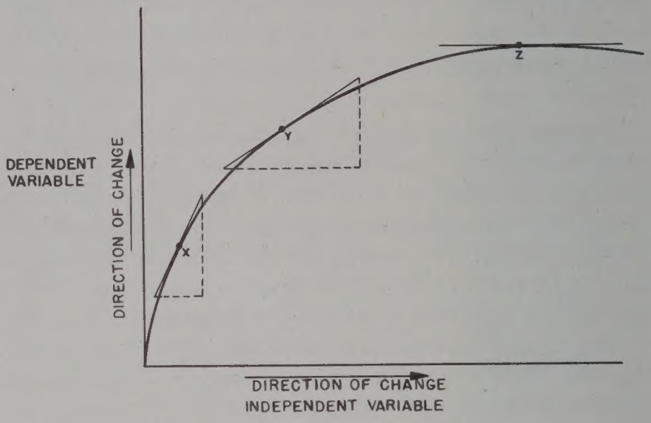


Figure 4-4—Mathematical Differentiation Example

2. POWER SUPPLY UNIT.

a. GENERAL.—A single power supply unit is used to provide power at the required voltages for both the Receiver and the Indicator Units. This power supply furnishes regulated plate voltage for the vacuum tubes, high voltage for the cathode ray tube, and filament or heater power for all tubes.

Incorporated in the power unit is a power line filter. The incoming power line is shielded between the power receptacle and this filter. The filter removes commutator and switching transients which have radio frequency components and prevents the occurrence of abnormally high noise levels in the receiver due to power line interference. This is a double section, low-pass filter and produces an attenuation of more than 60 db in the frequency range from 600 kc to 15 mc.

In addition to the line filter, all transformers contain an electrostatic shield which reduces the amount of primary noise transferred to the secondary circuits. The location of the filter and transformers in the circuit are shown on the Schematic Diagram of the Power Supply Unit, Fig. 7-25 to be found at the rear of the book.

The Power Supply is fused in the incoming power line. To obtain adequate protection, a five ampere fuse should be used with a 115 volt supply, and a two ampere fuse should be used with a 230 volt supply. The fuses must be changed whenever a change is made from operating at one voltage to operating at the other. Either 50 or 60 cycle supply voltage is satisfactory for operating the equipment.

The double-pole, single-throw switches S301 and S302, the "ON-OFF" and the "115 v. /230 v." switches respectively, are so interconnected that they give the following conditions of operation.

		S302 Thrown to 115 V.		S302 Thrown to 230 V.	
		Space Heaters	Power Transformers Windings	Space Heaters	Power Transformers Windings
S301	ON	OFF	ON In Parallel	OFF	ON In Series
	OFF	ON In Parallel	OFF	ON In Series	OFF

b. TRANSFORMERS.—There are two transformers in the Power Supply, one for the Receiver and Indicator tube power requirements and one for the cathode ray tube high voltages. The Power Supply transformer T301 has two separate 115 volt primary windings which can be paralleled for 115 volt operation, or series connected for 230 volts. The high voltage transformer has one 115 volt primary winding which is connected in parallel with one of the windings of the power transformer, and thus is always supplied with 115 volts regardless of whether the power transformer is series or parallel connected.

The power transformer T301 supplies the following R.M.S. voltages:

1. 880 volts—center-tapped to produce the 440 volt input for the plate voltage rectifier.
2. 5 volts—low voltage rectifier tube filament
3. 2.5 volts—one high voltage rectifier tube filament
4. 6.3 volts—regulator and control tube filaments
5. 6.9 volts—vacuum tube heaters

The high voltage transformer, T302, supplies the following R.M.S. voltages:

1. 1600 volts—to voltage doubling circuit for the cathode ray tube
2. 6.3 volts—cathode ray and restorer tube filaments
3. 2.5 volts—high voltage rectifier filament

c. HIGH VOLTAGE RECTIFIERS.—The positive half cycles of the 1600 volt transformer (T302) output are rectified by tube V307. The capacitor C306C serves as a filter for the rectifier output, maintaining the high voltage during the negative half cycles. The resistors R311 to R317 act as a bleeder for the capacitor so that it will not remain charged when the equipment is turned off. The positive output of this rectifier is approximately 2150 volts, d-c, and supplies the third anode, the coating on the inside of the bulb of the cathode ray tube.

The negative half cycles from the same high voltage transformer are rectified by V306. The negative d-c voltage is approximately 1800 volts when it comes from the low-pass, Pi-type filter C306A, R310, and C306B. This negative voltage supplies the cathode, the control grid (grid No. 1) and the focusing anode (anode No. 1) of the cathode ray tube.

d. LOW VOLTAGE RECTIFIER.—The plate voltage for the vacuum tubes in the Receiver and Indicator Units is supplied by the 880 volt winding of the power transformer T301. The center tap of the winding is grounded and the ends are connected to the plates of the full-wave rectifier tube V301, giving approximately 440 volts direct-current output. The Pi-section filter C301, L305, and C302 serves as a capacity input filter for the tube and this filter removes most of the 120 cycle ripple from the rectifier output.

e. VOLTAGE REGULATOR.—The voltage regulator for the power supply consists of three parts (Fig. 4-5):

1. The series regulator tubes, V302 and V303, which are used as valves.
2. A d-c amplifier, V304 sections 1 and 2.
3. A voltage reference, V305, which is fixed and against which the voltage output of the regulator is compared.

The output from the rectifier and Pi-section filter is applied to the plates and screens of tubes V302 and V303 which act as valves, or series regulators. A resistor is put in series with the screen grid of each tube (R301 and R324), and in series with the control grid of each tube (R303 and R305), to prevent oscillation within the regulator itself.

All of the plate and screen current of the Indicator and Receiver Units must flow through these tubes. The tubes are in parallel and carry about 75 ma. each. R304 and R306 in the cathodes of the regulators provide a small amount of self bias for balancing the load. If the current through V303 tends to become greater than that through V302, the voltage drop across R306 will be greater than the drop across R304, and will give a slightly larger bias to V303. The larger bias will reduce the current in that tube, and cause the total load current to be more equally divided between the two valves. The regulated output is taken from the bottom of the cathode resistors.

If an external source of grid bias is applied to the grids of V302 and V303 which makes the grids more negative, either less current will flow through the tubes and the voltage across them will remain the same, or the same current will flow through them and the voltage across will increase. If the grids are made more positive, more current will flow with the same voltage

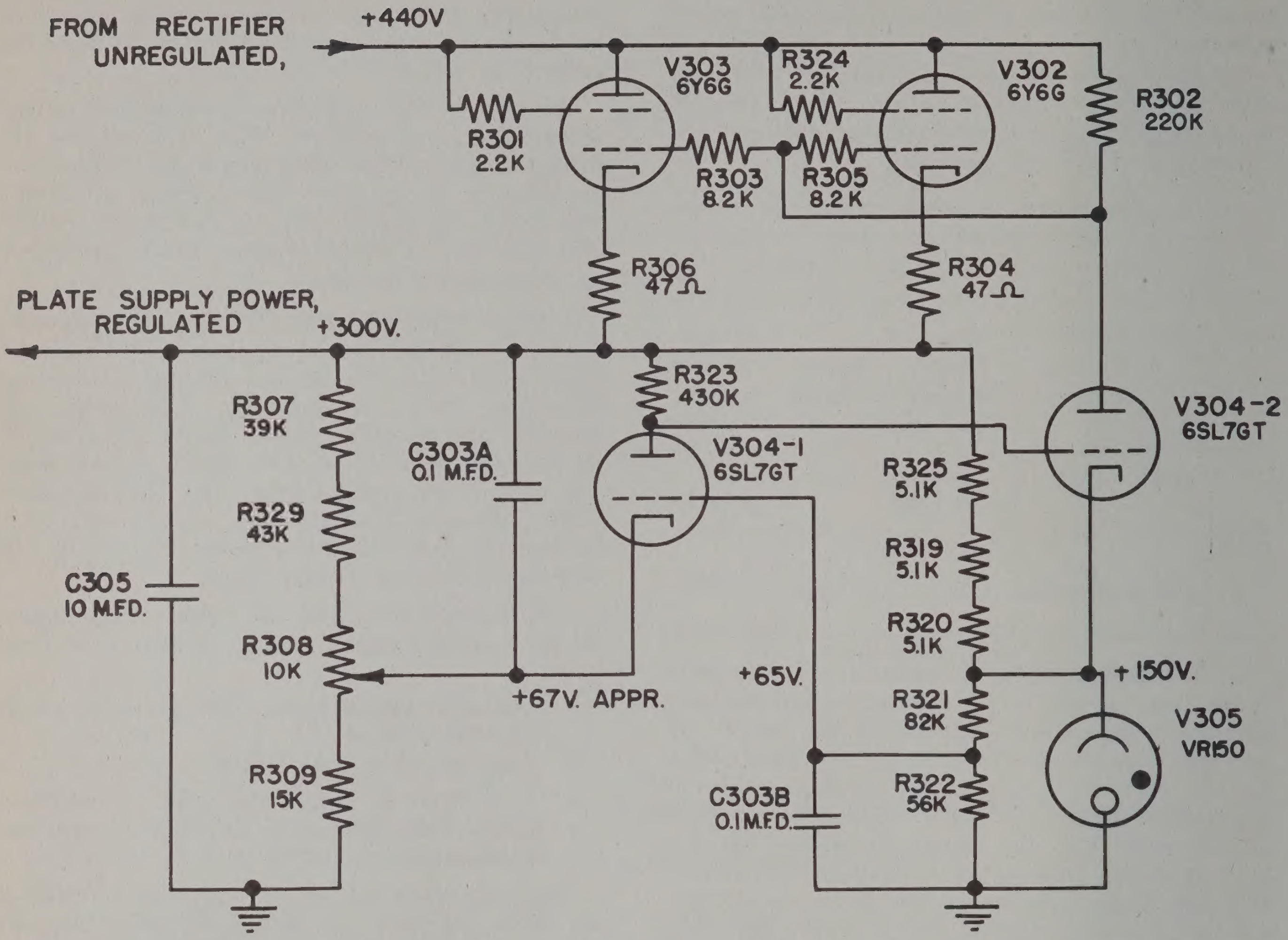

FROM RECTIFIER
UNREGULATED,
+440V
V303
6Y6G
R324
2.2K
V302
6Y6G
R302
220K
R301
2.2K
R303
8.2K
R305
8.2K
R306
47Ω
R304
47Ω
PLATE SUPPLY POWER,
REGULATED
+300V.
R323
430K
R307
39K
C303A
0.1 M.F.D.
V304-1
6SL7GT
V304-2
6SL7GT
R325
5.1K
R329
43K
R319
5.1K
C305
10 M.F.D.
R320
5.1K
R308
10K
+67V. APPR.
+65V.
+150V.
R321
82K
V305
VR150
R309
15K
C303B
0.1 M.F.D.
R322
56K

Figure 4-5—Voltage Regulator Circuit Diagram

drop across the tubes, or the same current will flow with a smaller voltage drop. This characteristic is made use of in regulating the voltage, as follows. When the load on the power supply is constant the current through the regulator tubes, in series with the load, is constant and the voltage drop across them does not vary. The voltage to the load is the rectifier filter voltage minus the drop in the tubes, therefore it too remains constant. Increasing the grid voltage under these conditions of constant current will decrease the drop across the tube and increase the output voltage to the load; decreasing grid voltage will decrease voltage to the load. By this means any desired value may be obtained.

Once the output voltage has been established, if the load is allowed to vary, then the current through the tubes will vary and normally tend to change the drop across them. When the current increases, however, increasing the grid potential of the tubes will prevent the change in voltage, and the output potential will remain constant. When the load decreases, decreasing grid potential will prevent the decrease in drop across the tubes.

To produce the proper variations in grid voltage, a two stage direct current amplifier is used. This amplifier is composed of the two sections of V304 and has a high gain. It is desired to keep the output to the load at 300 volts and it is necessary to have some measuring device or reference to compare the output against as a standard. A battery with constant voltage could be used, but it would age and require frequent replacement. Instead, the voltage regulator tube V305 is used, which is a gas-filled tube that maintains a constant voltage drop of approximately 150 volts across it over a considerable range of current.

Variations in the 300 volt output of the regulator are compared to this tube as a reference and the differences are amplified by V304. These amplified differences are the external voltage variations applied to the grids of V302 and V303 to control the voltage drop across them as described above.

The circuit connections for the amplifier and reference tube are shown in Fig. 4-5. The grid of V304-1 and the cathode of V304-2 are held at constant values by V305. The cathode of V304-1 is connected to the voltage dividing circuit R307, R329, R308, and R309 by the variable tap on R308. The tap is used to set the initial output voltage by fixing the bias on V304-1. This bias will determine the current in the tube and hence the plate voltage. The plate of V304-1 is coupled to the grid of V304-2 and so fixes the bias on that tube, the current through it, and hence its plate voltage. The plate of V304-2 is coupled to the grids of the regulator tubes and so fixes the voltage drop across these tubes as has already been explained.

If the load is increased, lowering the output voltage, the potential at the tap on R308 is also lowered. This decreases the negative grid bias on V304-1, which causes an increase in its plate current with an accompanying fall in plate voltage. This fall in plate voltage of V304-1 increases the negative grid bias of V304-2, makes it conduct less current, and increases its plate voltage. The increased plate voltage decreases the negative bias on the regulator tubes V302 and V303 and reduces the drop across them, bringing the output voltage back up to normal.

Any rapid fluctuations in the load require a more rapid response from the regulator, and therefore are applied directly to the cathode of V304-1 through the capacitor C303A. The effect on the amplifier and regulator is the same as for a long time fluctuation but the action is much more rapid.

The capacitor C305 aids the regulator in the case of rapid load fluctuations. There is some time delay in the amplifier circuit, and in the regulator tubes themselves, so when a sharp load fluctuation occurs C305 supplies the load until the regulator tubes can operate.

Another cause for output fluctuations is a change, or fluctuation, in the a-c supply voltage. Such a change will be divided proportionately between the voltage drop across the regulator tubes and the regulated output. The part of this fluctuation which appears in the regulated output will act like any other fluctuation to vary the grid of the first tube in the amplifier and correct itself. In other words, the output voltage of the regulator is independent of all except the bias on the first amplifier tube, and the reference voltage.

3. RECEIVER UNIT.

a. GENERAL.—The block diagram, Fig. 4-6, shows the stages in the seven tube super-heterodyne Receiver, and also the Antenna Matching or Loading coil. Four complete sets of tuning coils adjust the receiver to four different channels, and each set of coils may be tuned to any frequency within the channel range. Only one set of coils is in the circuit at one time, and the connections are all made by one control switch.

The equipment is designed for wide-band reception, having an overall bandwidth of greater than 75 kc at 6 db down, but not more than 250 kc at 40 db down. The minimum sensitivity and signal-to-noise ratio is such that a two microvolt continuous wave test signal, 50 per cent modulated with 400 cycles, is distinguishable through the noise; a five microvolt continuous wave test signal, 100 per cent modulated, produces a deflection of at least one inch of the trace on the cathode ray tube in the Indicator Unit.

All of the coils used in the Receiver are of the permeability-tuned type. The core is so mounted that when

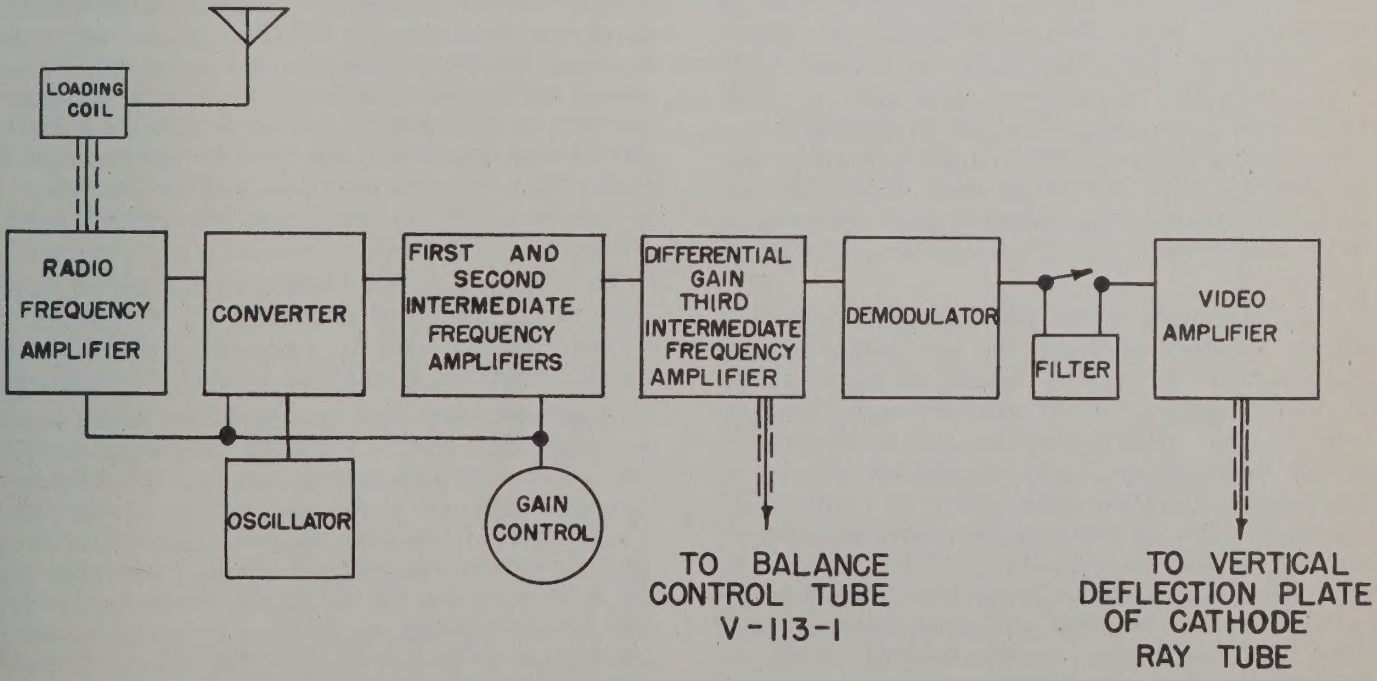

LOADING COIL
RADIO FREQUENCY AMPLIFIER
CONVERTER
FIRST AND SECOND INTERMEDIATE FREQUENCY AMPLIFIERS
DIFFERENTIAL GAIN THIRD INTERMEDIATE FREQUENCY AMPLIFIER
DEMODULATOR
FILTER
VIDEO AMPLIFIER
OSCILLATOR
GAIN CONTROL
TO BALANCE CONTROL TUBE V-113-1
TO VERTICAL DEFLECTION PLATE OF CATHODE RAY TUBE

Figure 4-6—Receiver Unit Block Diagram

the screw on the end of the coil is turned clockwise, the core moves into the coil and increases the inductance. Turning the screw *in* will therefore *lower* the tuned *frequency.*

The Receiver input circuit consists of r-f, auto-transformer coils L405, 406, 407, and 408 which are tapped at such a point that an input at a 50-ohm level will result in maximum gain and correct bandwidth. A 50-ohm coaxial transmission line is used to couple the antenna to the receiver, and since the antenna as installed aboard ship may vary considerably in length and capacity to adjacent structures, a loading-coil is necessary to tune out the residual reactance. A vertical antenna, exactly one-quarter wave long (or approximately 120 feet) would present no reactance to its feeder and hence would need no loading-coil. Obviously this is seldom possible in practice. The coil is tapped along its length to allow adjustment for best signal strength for the 1700 to 2075 kc tuning band. A compromise adjustment must be made if several channels in this range are in use.

b. RADIO FREQUENCY AMPLIFIER.—The schematic diagram of the Receiver Unit is shown at the rear of the book, Fig. 7-26. The signal from the antenna is transferred by means of switch S401A, to one of the four coils L405, L406, L407, or L408. Each coil, representing one of the four channels, is tuned separately and the antenna input is tapped down on them to give a low impedance input which will match the fifty ohm cable. S401A also selects the proper coil connection to the grid of the radio frequency (r-f) amplifier tube, and short circuits the other coils. The gain of the coils alone, due to these connections, is approximately eight.

The amplifier tube, V401, is a high gain 6AC7. In addition to the bias resistor R402 in the cathode circuit, which furnishes minimum bias, the cathode is also in series with the gain control potentiometer. This potentiometer therefore regulates the tube bias and hence gain.

The plate circuit is tuned by means of coil L409, L410, L411, or L412, according to the radio frequency channel selected by switch S401B. S401A and S401B are ganged together and since each of the plate circuit coils also represents one of the four channels, they must be tuned to the same frequency as the corresponding coils in the grid circuit.

The overall gain of the r-f stage and antenna coil for the maximum setting of the gain control is more than 100. The i-f stages of the unit are tuned to 1100 kc, which is in the standard broadcast range. Many unwanted signals at the i-f frequency may be present, and if not attenuated would pass through the Receiver as interference. Therefore three wave-traps tuned to approximately the i-f frequency are provided in the r-f stage to increase the rejection at i-f frequencies. The first trap, composed of L401 and C401, is between the grid of the R.F. amplifier and ground, and the third trap, L403 and C406, is between the grid of the converter tube and ground. These are both series resonant circuits. The second trap, composed of L402 and C402, is in the screen circuit of the r-f amplifier and is a parallel resonant trap. The first and third traps, therefore, offer low impedance paths to ground for the signals in the i-f passband frequencies to which they are tuned, and the second trap blocks the signal to which it is tuned by producing a high degree of degeneration to it in the r-f tube.

The traps are not all tuned exactly to the i-f frequency but are staggered over not more than a 100 kc range. In this way they suppress signals within 50 kc on either side of the 1100 kc center or intermediate frequency.

It is possible, by tuning these traps to certain frequencies, to set up conditions which are conducive to oscillation of the r-f stage at the i-f frequency. This oscillation in general will only be noticed when the gain control is set near maximum and the sensitivity of the Receiver is much more than required. The wave traps are set at the factory so that conditions for oscillation do not prevail, but should it be necessary to disturb the traps at any time they should be readjusted to frequencies as follows:

trap #1—1060 kc (L401)
trap #2—1100 kc (L402)
trap #3—1140 kc (L403)

If they are so adjusted it will be found that the rejection of frequencies in the i-f passband is substantially flat. Should the rejection not be entirely satisfactory a slight readjustment will not cause any difficulty.

c. CONVERTER.—The oscillator is a type 6SA7 tube (V402) used in a Colpitts circuit, temperature compensated so that drift is less than ten per cent of the overall bandwidth for an ambient temperature range of 0 to 50°C. Switch S401C is ganged to C401A and S401B, and selects one of the coils L413, L414, L415 or L416 for the oscillator inductance. These coils are individually tuned to a frequency that will beat against the corresponding channel frequency to produce an 1100 kc intermediate frequency. On bands 1 and 2 the oscillator operates at a frequency 1100 kc higher than the received signal frequency, and on bands 3 and 4 (with the original higher frequency channels) the oscillator operates at a frequency 1100 kc lower than the received signal frequency.

The r-f signal is R-C connected from the r-f stage plate to the third grid of V402 by C407 and R403. Cathode bias for V402 is controlled, in parallel with the R-F Amplifier, by the Gain Control potentiometer.

In both the Model DAS and the Model DAS-2 units, two frequency ranges 1.7 to 2.075 mc, and 9.9 to 12.1 mc, are covered, each by two channels. (One channel consists of one coil in the grid and one in the plate circuit of the R.F. amplifier, and one coil in the oscillator circuit). The corresponding oscillator frequences are 2.8 to 3.175 mc and 8.8 to 11.9 mc. Notice that for the first frequency range the oscillator frequency is above the r-f., and for second range it is below, as pointed out before. It has been found advantageous, however, to make all four channels, or frequency ranges, the same. This is done by replacing two sets of coils, those for channels three and four, and all channels then cover the 1.7 to 2.075 mc range. Kits which contain the replacement coils necessary for making this change in the field have been prepared for shipment to all units. These coils may easily be installed, and no other alterations are required for the channel conversion.

d. FIRST AND SECOND INTERMEDIATE FREQUENCY AMPLIFIERS.—The first two i-f stages of the Receiver Unit have identical circuits. The tubes, V403 and V404, are 6SK7 tubes connected as simple pentode amplifiers, the first having a gain of approximately 25 and the second a gain of approximately 29. The cathode bias of both of these tubes is also regulated by the Gain Control setting in parallel with the two preceding tubes.

Because wide band amplification is desired, a low-impedance capacity coupled transformer is used in the i-f stages. Transformers T401, T402, and T403 are so constructed that there is very little mutual inductance, and the coupling is actually accomplished by capacitors. The tuning capacitance of the primary circuit is obtained through two capacitors in series, connected between the plate of the tube and ground. The capacitor on the ground side is also in series with a capacitor which is connected to the grid of the following stage, and forms a part of that tuning circuit. The common capacitor offers some impedance to the i-f signal and a voltage is developed across it. Because this capacitor is in both the primary and the secondary circuits (plate and grid), its voltage induced by the primary circuit becomes a part of the secondary voltage. This gives the desired amount of over-coupling, and when the circuits are tuned to 1100 kc the pass-band is more than 90 kc at 6 db down.

e. DIFFERENTIAL GAIN, INTERMEDIATE FREQUENCY AMPLIFIER.—As explained in the Introduction, the pulses from the Master and Slave stations are received alternately. Conditions such as relative distance from the transmitters may make one of these signals much stronger than the other, and they must be balanced. The timing circuit, which will be explained under the Indicator Unit, controls the cathode voltage on the third i-f amplifier in such a way that the bias is greater than normal during the time the strongest signal is being amplified, reducing its amplification.

The Balance Control tube in the Indicator, V113 Sec. 1 and 2, requires a cathode-to-ground potential of approximately 25 volts for plate current cut-off, and because the cathode of the i-f tube, V405, is in parallel with the cathode of the Balance Control tube they both must have the same cathode potential. The resulting bias of approximately 25 volts would materially affect the gain of the stage, hence the grid of the tube is given a positive voltage also. This voltage is about 19 volts, established by the voltage divider R436 and R437 between the 300 volt supply and ground. The resulting bias on the amplifier is then normally about six volts, giving a gain of eight to the stage. The effect of the Balance Control tube in operation is to increase the bias and reduce the gain of the stage. A further description of the balance gain operation is given on page 4-44.

The coupling between the Third I-F Amplifier and the Demodulator is not the same as that used between previous stages. The low impedance capacity coupled circuit does not lend itself well to this shunt-diode negative-output circuit, and hence a small capacitor, C429, is connected directly between the primary and secondary windings of T404 to give the required coupling for the wide pass-band.

When the i-f stages are properly aligned, response curves like those in Fig. 5-2 may be obtained. To check the alignment an oscilloscope is placed across the diode load resistor R417. An intermediate frequency sweep signal, which sweeps frequencies in the range of 950 to 1250 kc, is fed into the grid of each tube in order, starting with the third I-F Amplifier, and is also used to synchronize the oscilloscope.

Quite often in the field a sweep signal generator is not available for aligning the i-f stages. In an emergency, therefore, it may be necessary to align these stages without proper equipment and for this purpose the terminals A1, A2, and A3 are provided. Connecting these terminals to ground shorts out the common capacitors C412, C418, and C423 and leaves only the mutual inductance coupling of the transformers between stages. This gives a narrow pass-band, as shown in Fig. 5-4, which may be adjusted with an ordinary signal generator. Since the capacitors which are normally in series with the tuning are shorted out, the capacity which tunes the transformers is slightly more than normal, and hence the resonant frequency is lowered to 1065 kc as shown on the curves. When the short circuits across C412, C418, and C423 are removed the tuning capacity is reduced and the resonant frequency returns to 1100 kc, giving curves very similar to Fig. 5-2. This method of aligning the i-f stages is not too accurate, however, and is provided for an emergency only.

f. DEMODULATOR.—The pulse modulated signal is rectified by V406, and the negative portion appears across the diode load resistor R417. This resistor value is kept low and the filtering capacitance C431 is made a minimum so that high frequency response will not be lost.

The filtering inductance, L400, is a high impedance r-f choke with very low distributed capacity. It offers a high impedance to the i-f frequency carrier and thus keeps r-f out of the video, yet has low impedance to the video signal.

g. VIDEO FILTER.—An additional filter is provided for the video signal, and is located between the Demodulator and the Video Amplifier. This filter may be switched in or out of the circuit by turning a knob on the front panel of the Receiver, and it reduces video signals at frequencies in excess of 10,000 cycles by less than two to one, but reduces video frequencies below 1000 cycles by more than 20 to 1. This effectively reduces low frequency noise, modulated carrier interference, and other low frequency interference while the desired pulse is not greatly affected except for a shortening in its length. The overall responses of the receiver, from r-f input to deflection of the beam on the cathode ray tube, both with the filter in the circuit and with the filter shorted out, are shown in Fig. 5-3 in the Maintenance section of the book.

b. VIDEO AMPLIFIER.—The video amplifier V407, a 6AG7 tube, is run at zero bias to normally operate the plate at a very low potential When a negative pulse is applied to the grid, the plate current decreases and the plate voltage approaches the supply voltage. The Video output is developed across a resistance plate load, and conducted by a shielded cable to the cathode ray tube in the Indicator Unit. In series with the cable is an inductance, L404, which compensates for the high capacity of the video cable and preserves video response at the higher frequencies.

Gain between the diode load and the cathode ray tube is reduced by the filter. Filter-out gain is approximately 95 and filter-in gain is approximately 45. The positive pulse from the receiver is connected to the upper deflection plate of the cathode ray tube, and causes an upward deflection of the trace.

4. INDICATOR UNIT.

a. CRYSTAL OSCILLATOR.—The Oscillator circuit shown in Fig. 4-7 is a variation of the common tuned-grid tuned-plate oscillator. In this circuit, however, the frequency of oscillation is chiefly determined by the 100 kc crystal Y101 in shunt with the grid circuit. The circuit will oscillate without the crystal, but it will be off frequency and unstable. A high mu triode type 6SL7 oscillator is used in order to reduce crystal current to a low value and minimize crystal heating.

Coil L101 is tuned to 100 kc by means of C192, C102, C169, C103, C105, the crystal holder capacity, and the stray capacity in the grid circuit. C101 is an isolating capacitor necessary to keep direct current from flowing in L101, and also functions as the grid capacitor for the Oscillator. Capacitor C105 is used to augment the tube inter-electrode capacitances for the purpose of feedback and is necessary to produce sufficient feedback for oscillations. Resistor R101 is the grid leak resistor and has been made high in value in order to minimize crystal loading. L102 and C106, constituting the tuned plate circuit, resonate at approximately 120 kc; thus presenting a high inductive reactance plate load to the tube, which results in a high Oscillator output level and the correct phase of feedback for oscillation. Resistor R102 and capacitor C107 constitute an r-c filter in the 500 volt supply load for isolation purposes.

The LEFT-RIGHT control S101A is a neutral center switch serving as a "step" frequency control. In its center position it shunts C103 across the crystal Y101. Throwing the switch to the left places C103 and C104 in shunt with the crystal, thereby lowering the Oscillator frequency by approximately 40 parts in one million. Throwing this switch to the right removes C103 from the grid circuit, thus increasing the frequency by approximately 40 parts per million.

The air trimmer C102 serves as a "fine" frequency control used to correct for temperature drift of the crystal and circuit components in order to make the sweep recurrence rate of the equipment exactly synchronize with the recurrence rate of the received pulses. Tuning C102 through its range produces a change in Oscillator frequency of approximately ±220 parts per million at an ambient temperature of 25°C. Crystal data and characteristics are included in the Maintenance section of this book.

b. CRYSTAL BUFFER.—The plate of the Crystal Oscillator is coupled to the grid of the 100 kc buffer through the blocking capacitor C113, and the limiting resistor R107 (Fig. 4-7). R107 acts as a limiting resistor because a voltage drop appears across it as soon as the tube starts to draw grid current. Resistor R108 acts as the grid leak to bias the buffer grid. Resistors R109 and

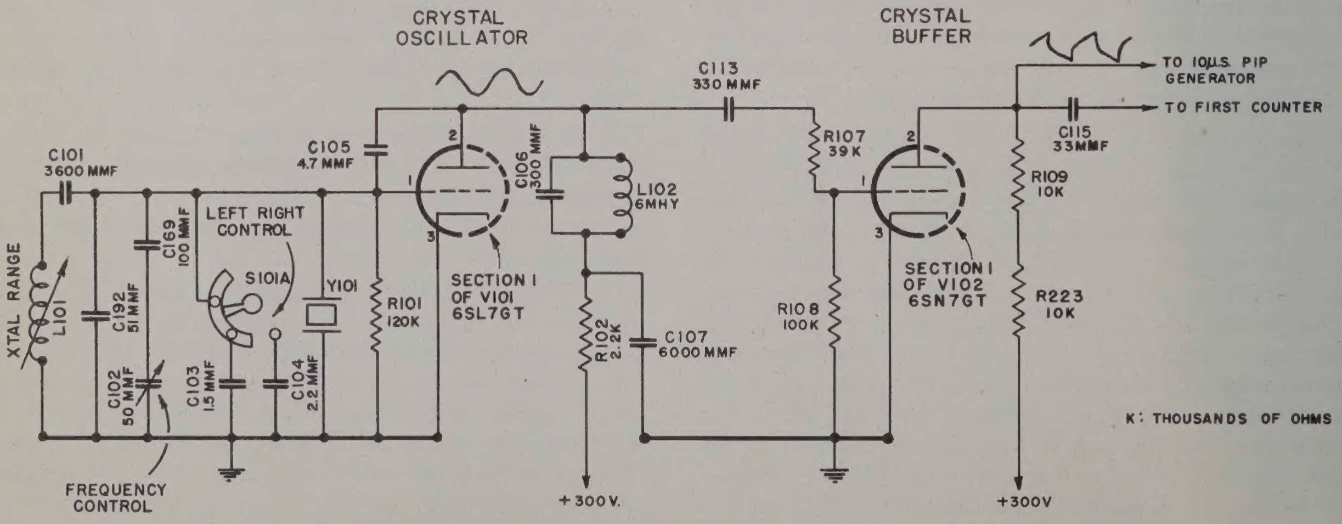


Figure 4-7—Crystal Oscillator and Crystal Buffer Circuit Diagram

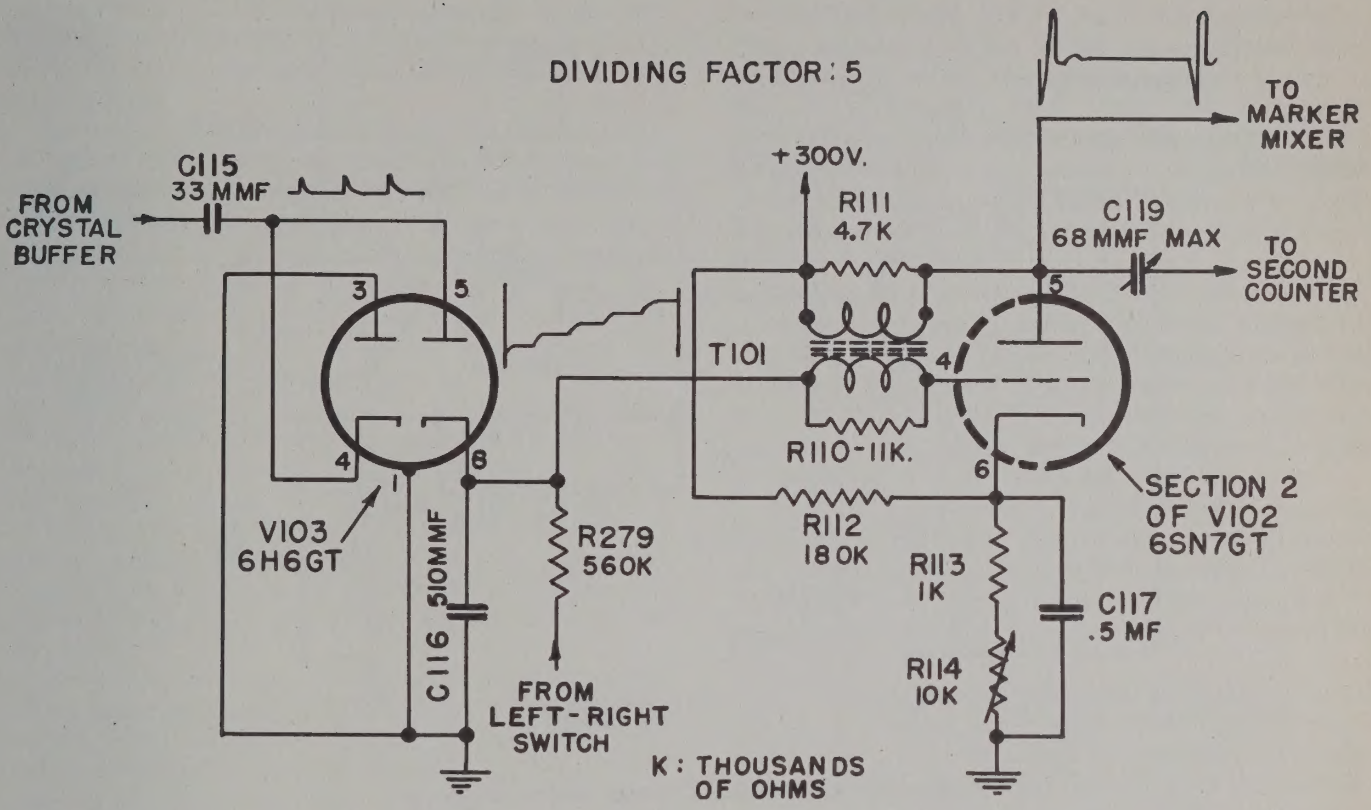

DIVIDING FACTOR: 5
FROM CRYSTAL BUFFER
C115
33 MMF
3
5
4
1
6
V103
6H6GT
C116 510MMF
R279
560K
FROM LEFT-RIGHT SWITCH
T101
+300V.
R111
4.7K
R110-11K.
R112
18 0K
R113
1K
R114
10K
C117
.5 MF
4
5
6
C119
68 MMF MAX
TO MARKER MIXER
TO SECOND COUNTER
SECTION 2 OF V102 6SN7GT
K: THOUSANDS OF OHMS

Figure 4-8—First Counter Circuit Diagram

R223 are plate load resistors and two are used to reduce the power dissipation in a single resistor.

In passing through the Buffer tube V102-1, the 100 kc sine wave output of the Oscillator is distorted by clipping to make the leading edge steep (as shown in Fig. 4-9A), thus making the wave more suitable for applying it to counters. The Buffer stage is used to isolate the uneven load of the First Counter from the Crystal Oscillator, provide a low impedance drive to the First Counter, and to remove the amplitude variations in the crystal output.

c. FIRST COUNTER.—The output of the Crystal Buffer is coupled to the First Counter stage by the capacitor C115. The counters, or frequency dividers, are essentially combined blocking oscillators and voltage accumulator tripping circuits. The circuit of the First Counter is shown in Fig. 4-8.

The cathode of the blocking oscillator, V102-2, is biased to approximately 50 volts positive by means of the fixed resistor R113 and the variable resistor R114. The latter is brought out to the front panel as the screwdriver adjustment "C1". Since the tube current of this stage is not sufficient in itself to produce the required bias, R112 is used as a bleeder resistor from the 300 volt supply to furnish the additional current through R113 and R114, and hence obtain the proper voltage drop.

Capacitor C117 serves as the cathode by-pass capacitor, and the d-c grid bias on the tube is the difference

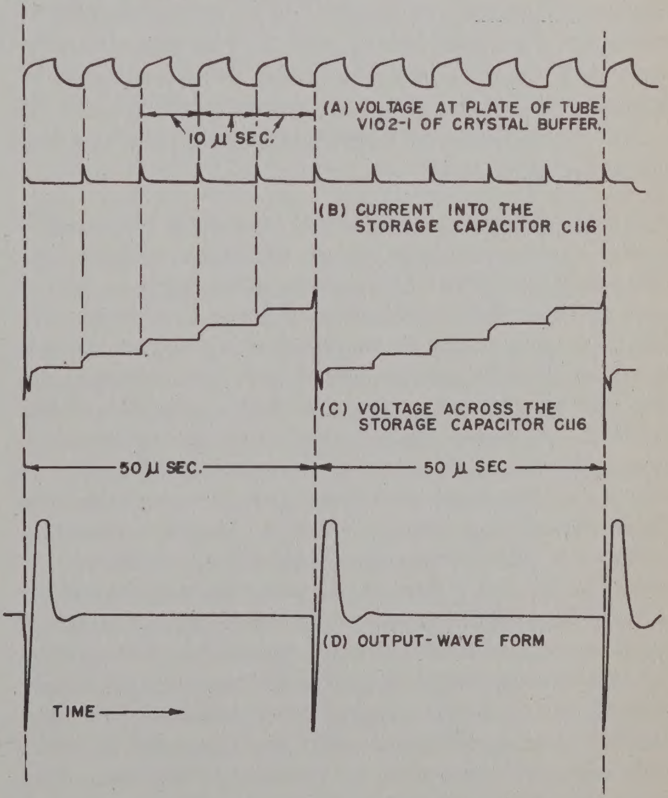


Figure 4-9—First Counter Waveforms

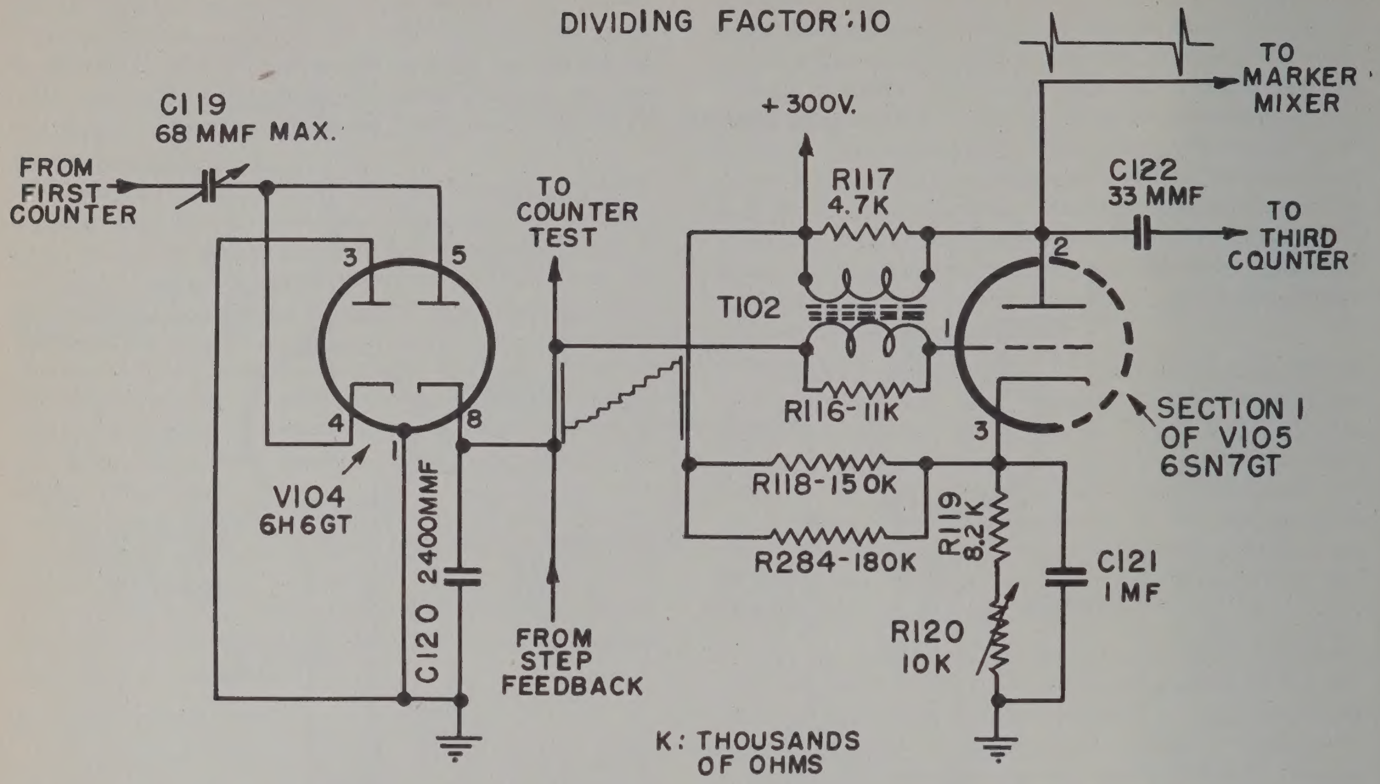

DIVIDING FACTOR: 10
C119
68 MMF MAX.
FROM FIRST COUNTER
TO COUNTER TEST
FROM STEP FEEDBACK
V104
6H6GT
3
5
4
8
1
C120 2400MMF
+300V.
R117
4.7K
T102
R116-11K
R118-150K
R284-180K
R119
8.2K
R120
10K
C121
1MF
2
1
3
SECTION I OF V105 6SN7GT
C122
33 MMF
TO THIRD COUNTER
TO MARKER MIXER
K: THOUSANDS OF OHMS

Figure 4-10—Second Counter Circuit Diagram

between the voltage across C116 (grid-to-ground voltage) and the voltage across C117 (cathode-to-ground voltage). The grid cut-off voltage with respect to the cathode is approximately—20 volts. With no charge on capacitor C116, the grid is at ground potential and the +50 volts cathode bias therefore holds the tube well into plate current cut-off.

The coupling capacitor C115 alternately passes small positive pulses of current when the plate voltage of the Crystal Buffer (V102-1) increases, and negative pulses of current when the plate voltage of V102-1 decreases. The negative pulses applied to pin 4 of V103 pass directly to ground while the positive pulses pass through pins 5-8 of V103 to storage capacitor C116, as shown in Fig. 4-9B. As the pulses cannot return through the duo-diode, the potential of C116 (and consequently of grid 4 of V102-2) is raised one *step* above ground for each positive input pulse (Fig. 4-9C). When 5 charges accumulate, at about 6 volts per charge, the grid is approximately 30 (6x5) volts above ground, or about 20 volts below the cathode and tube V103 becomes conductive. The rise in plate current induces a voltage across the grid winding of the transformer T101, this voltage being of such polarity as to drive the grid more positive. The plate current consequently increases, and the tube is driven to a high peak current in an extremely short time. This action is accompanied by a surge of grid current which discharges the storage capacitor, C116. When the plate current reaches a maximum value and ceases to rise, the voltage across the grid winding of the transformer T101 drops sharply. As the grid voltage drops, the tube becomes less conductive and the plate current begins to decrease, driving the grid to a still lower voltage. This process is cumulative and the tube is carried sharply

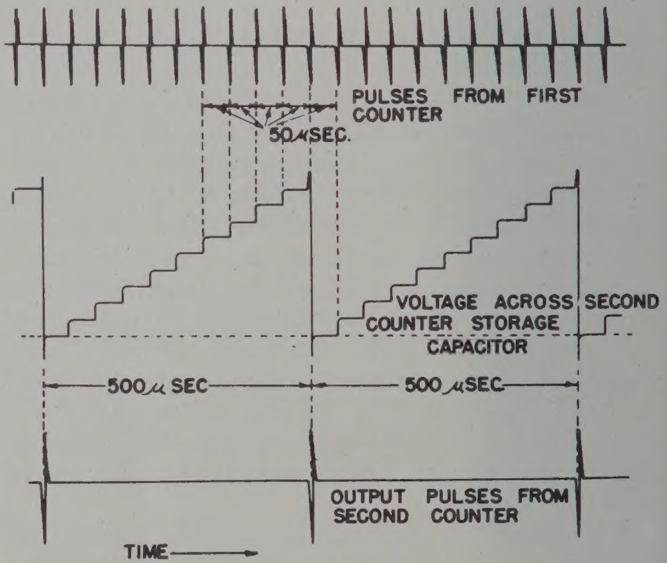


Figure 4-11—Second Counter Waveforms

past cut-off. The negative charge placed on C116 by the grid current surge when the tube stopped conducting is immediately reduced to ground potential by the conductivity of V103, and so the circuit elements are returned to their initial conditions; and the counting cycle begins again.

Each time V102-2 becomes conductive, the plate drops sharply from 300 to approximately 150 volts. When the tube suddenly stops conducting, the energy stored in T101 carries the plate voltage to approximately 450 volts (Fig. 4-9D). The period of the oscillation of the plate circuit is determined by the leakage reactance and distributed capacity of transformer T101; R110 and R111 provide damping of the oscillations. Fig. 4-9 shows the relationship of voltages and time intervals involved in the First Counter operation and it will be observed that the negative plate pulse is coincident in time with one of the input pulses through charging capacitor C115 and, therefore, the number of output pulses from this circuit will be an exact sub-multiple of the input pulses. When operating properly, this circuit divides the input frequency from the Crystal Buffer by 5 and therefore produces 20,000 pulses per second, or a pulse every 50 microseconds.

The proper operation of this circuit depends on the adjustment of the cathode resistor R114. This resistor, if varied, varies the cathode voltage and consequently determines the firing point of the tube. Therefore R114 must be adjusted to the center of the stable range which will make the tube fire after each group of five input pulses.

The action of the LEFT-RIGHT switch on this circuit will be explained later, under Delay Multivibrator Circuits.

d. SECOND COUNTER.—The 20 kc output from the First Counter is coupled through capacitor C119 to the Second Counter (Fig. 4-10) which, except for the feedback connection at storage capacitor C120, is essentially the same as the First Counter, and the principle of operation is identical. Capacitor C119 is adjustable to pass the proper size pulses from the First Counter to the Second Counter storage capacitor for operation in conjunction with the Feed-Back circuit. The Feed-Back circuit also delivers pulses to the storage capacitor which must be balanced with the First Counter pulses.

In Fig. 4-11 is shown the relation of input pulses, Second Counter storage capacitor voltage, and Second Counter output pulses. It should be observed that ten *steps* of voltage rise are required in the storage capacitor C120 in order to fire tube V105-1. The cathode of V105-1 is held at a positive bias of approximately 60 volts, and the value of capacitor C119 is adjusted to deliver about 4 volt pulses to the storage capacitor C120; thus 10 pulses will raise the grid of V105-1 to 40 volts above ground or to firing potential. Potentiometer R120 controls the cathode bias of V105-1 and is brought out to the front panel as screwdriver adjustment "C2" and must be adjusted so that ten steps will raise the grid to firing potential.

The second Counter divides the input frequency from the First Counter by 10, and therefore produces 2,000 pulses per second, or a pulse every 500 microseconds.

e. THIRD COUNTER.—The circuit diagram for the Third Counter is shown in Fig. 4-12. The 500 microsecond output pulses from the Second Counter are fed into the 6H6 double diode V106, through capacitor C122. The action of V106 is identical with that of V104 in the Second Counter, passing the negative portions of the pulses to ground through the diode 3-4 and building the positive pulses up on the storage capacitor C123 through the diode 5-8.

The operation of tube V105-2 is identical to V105-1 in the Second Counter; that is, it is normally biased well into cut-off by means of a posititve voltage of 60 volts applied at the cathode from the voltage divider R124, R123, R125, and R126, and produces a pulse at its plate whenever C123 charges the grid to the point of plate conduction.

As in the other counters, the amount of voltage rise on the grid required to fire the tube, and consequently the number of Second Counter pulses required, is determined by the setting of the cathode resistor R126 which is brought out to the front panel as screwdriver adjustment "C3".

The relation of input pulses, storage capacitor (C123) voltage, and output pulses for the Third Counter, is illustrated in Fig. 4-13. The Third Counter divides the input frequency from the Second Counter by 5 and therefore produces 400 pulses per second or a pulse every 2500 microseconds.

f. FOURTH COUNTER.—The circuit diagram for the Fourth Counter of the Model DAS is shown in Fig. 4-14. The Fourth Counter in the Models DAS-a and DAS-2 have the same circuit plus an alternate cathode circuit which may be inserted by means of a switch.

The circuit as shown in Fig. 4-14 is designed for an output of 50 cycles/sec., or a pulse every 20,000 microseconds. The Fourth Counter is again identical to the previously considered counters, however, the circuit constants give one output pulse for every 8 input pulses. The 2500 microsecond pulses from the Third Counter are fed in through capacitor C126; the negative portions of the pulses are passed to ground and the positive portions are charged upon the storage capacitor C122. The voltage divider R131, R130, R283 and R132 gives the cathode voltage (60 volts) for proper operation of the circuit. The adjustment of potentiometer R132 is brought out to the front panel as a screwdriver control and is marked "C4" on Models DAS and DAS-a, and "C4A" on Model DAS-2.

The alternate cathode circuit for the Fourth Counter present in Models DAS-a and DAS-2 consists of a 10,000 ohm potentiometer R186, and a switch, S105. Either of the potentiometers, R132 or R186, may be selected by the switch S105 to supply the cathode bias and the second potentiometer is adjusted so that only six (instead of eight) pulses from the Third Counter are required for one Fourth Counter pulse. This gives an alternate output rate of 66 2/3 cycles/sec. or a pulse every 15,000 micro-

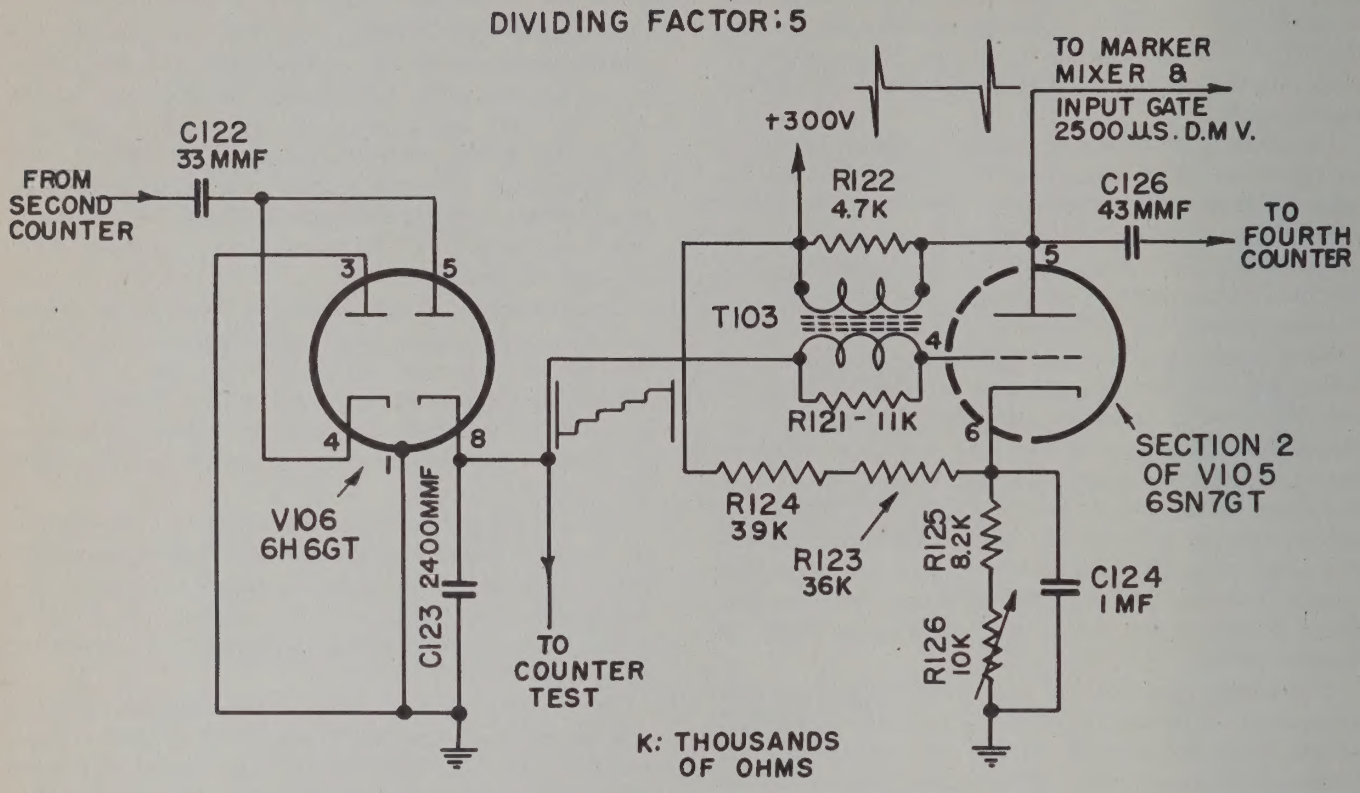

DIVIDING FACTOR: 5
TO MARKER MIXER & INPUT GATE 2500 µS. D.M V.
+300V
R122 4.7K
C122 33 MMF
FROM SECOND COUNTER
C126 43 MMF
TO FOURTH COUNTER
T103
3
5
4
1
8
4
5
6
V106 6H6GT
C123 2400MMF
TO COUNTER TEST
R121 - 11K
SECTION 2 OF V105 6SN7GT
R124 39K
R123 36K
R125 8.2K
R126 10K
C124 1 MF
K: THOUSANDS OF OHMS

Figure 4-12—Third Counter Circuit Diagram

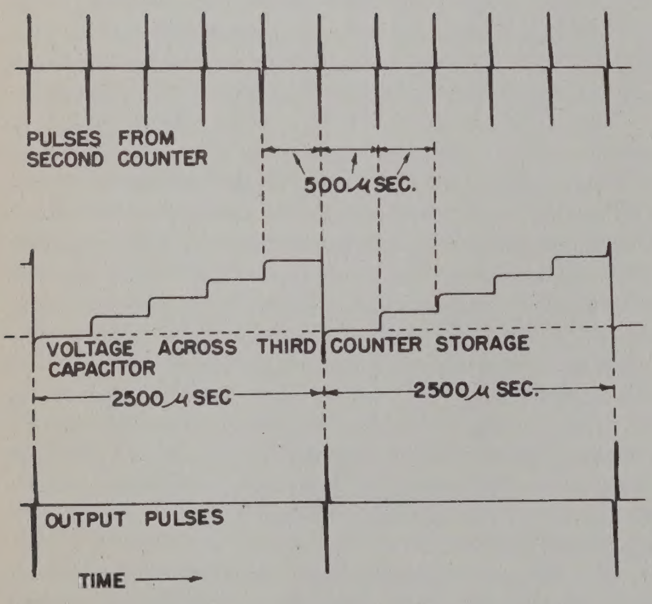


Figure 4-13—Third Counter Waveforms

seconds. In the latest units a 3000 ohm resistor is added in series with R132 to make the counter more stable on the L rate.

The potentiometer R186 adjustment is brought out to the front panel as screwdriver control "C4B". The switch S105 is also on the front panel and is marked "PRR" which stands for pulse recurrence rate. These two additional components form the basic difference between the Model DAS and Models DAS-a and DAS-2. The latter models can synchronize with Receiver pulses at a basic recurrence rate of both 33 1/3 and 25 per second, while the Model DAS can only synchronize with Receiver pulses at the 25 per second basic rate.

Note

The Potentiometer R186 can also be adjusted to a point which will make the Fourth Counter count six instead of eight. In this way, by adjusting "C4", the Model DAS can receive at the 33 1/3 cycle rate, but normally it is adjusted for 25 cycles. The 33 1/3 cycle rate is known as the *H* rate and the 25 cycles rate as the *L* rate.

g. STATION SELECTOR OR STEP FEED-BACK CIRCUIT.—The following explanation will be made with the assumption that the PRR switch, if the equipment has one, is set to L. It will be recalled that for normal operation (that is, with no feedback) ten First Counter output pulses are required to produce one output pulse from the Second Counter; five Second Counter output pulses are required to produce one output pulse from the Third Counter; eight Third Counter output

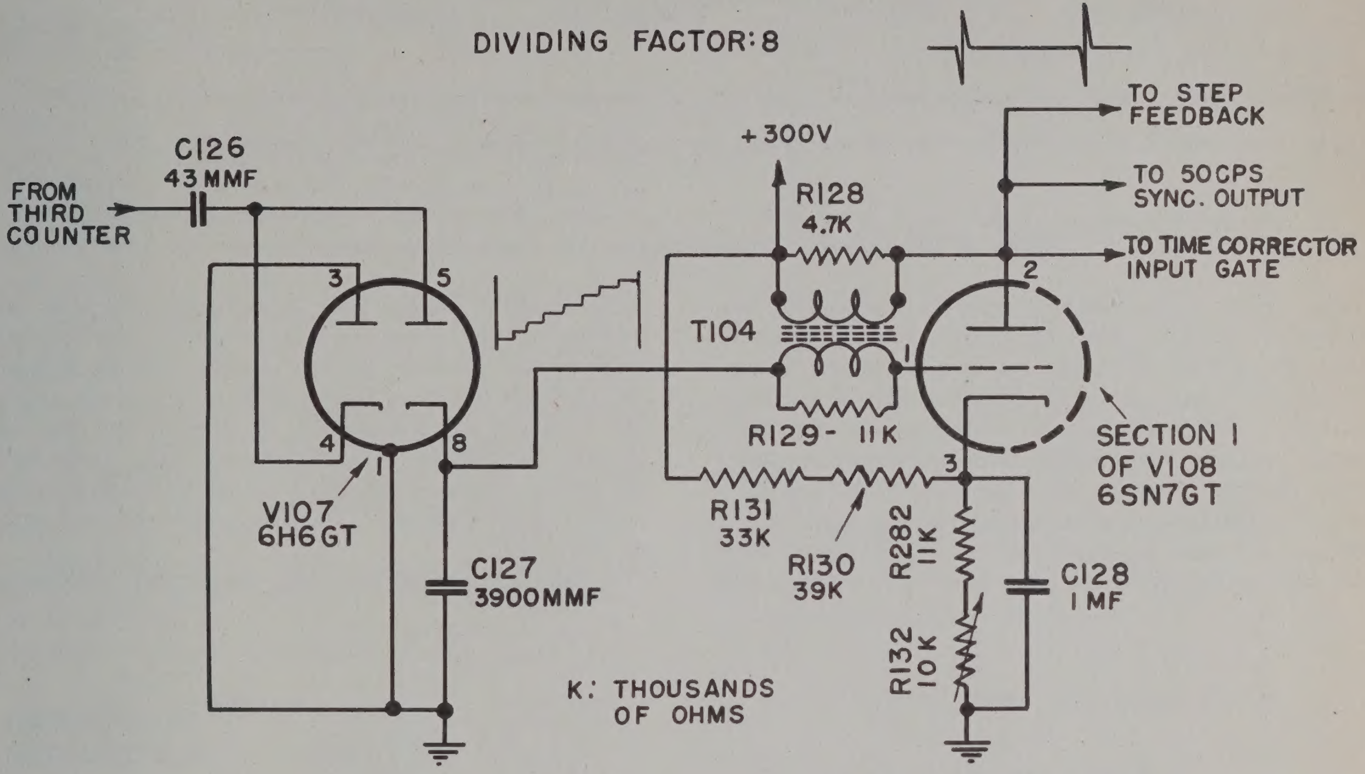

DIVIDING FACTOR: 8
FROM THIRD COUNTER
C126
43 MMF
3
5
4
1
8
V107
6H6GT
C127
3900MMF
+300V
R128
4.7K
T104
R129- 11K
R131
33K
R130
39K
R282
11K
R132
10K
C128
1 MF
1
2
3
TO STEP FEEDBACK
TO 50CPS SYNC. OUTPUT
TO TIME CORRECTOR INPUT GATE
SECTION I
OF V108
6SN7GT
K: THOUSANDS OF OHMS

Figure 4-14—Fourth Counter Circuit Diagram

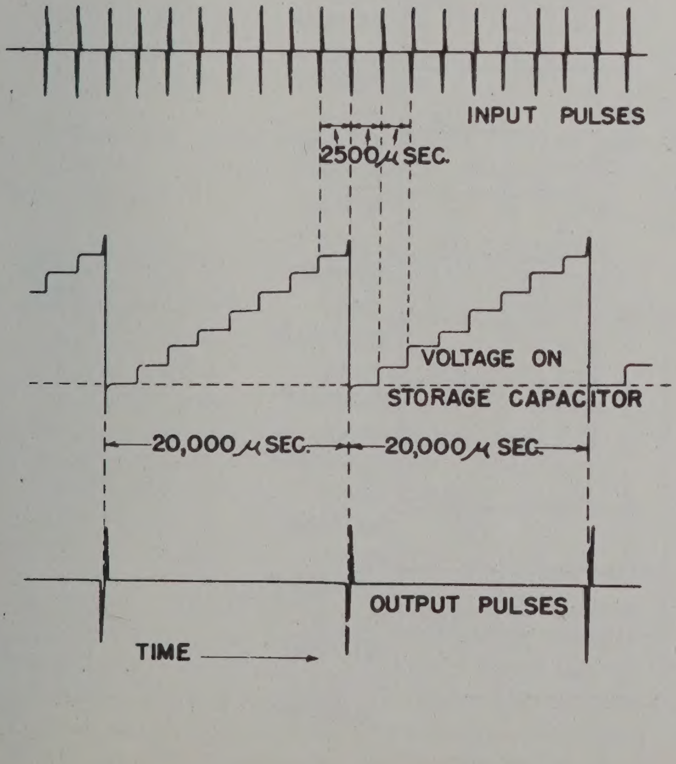


Figure 4-15—Fourth Counter Waveforms

pulses are required to produce one output pulse from the Fourth Counter. Therefore, it requires 10x5x8 or 400 First Counter output pulses to produce one Fourth Counter output pulse. Fig. 4-16 shows the frequency outputs of the respective counters, with interval durations, for normal operation with no feed-back.

The Step Feed-Back circuit shown in Fig. 4-17 provides a means of reducing the number of First Counter output pulses required to produce one output pulse from the Fourth Counter.

The group of capacitors C151 to C163 (Fig. 4-17) and the double diode (6H6) V118 function on the Second Counter exactly as do capacitor C119 and diode V104 the main counter chain (Fig. 4-10); that is, V118 passes the negative portions of Fourth Counter pulses to ground and charges up the Second Counter storage capacitor with the positive portions.

For illustration purposes it will be assumed that STATION Switch S104 (Fig. 4-17) is set to position 3. At this position condensers C154 and C155, when in proper adjustment, place a charge equal to 3 First Counter output charges on storage capacitor C120 of the Second Counter (Fig. 4-10) each time the Fourth Counter produces a pulse. The effect of this *feed-back* charge can be noted in Fig. 4-18. The dotted *flight of stairs* is the normal voltage on the Second Counter storage capacitor with no feed-back. Now when the Fourth Counter produces a

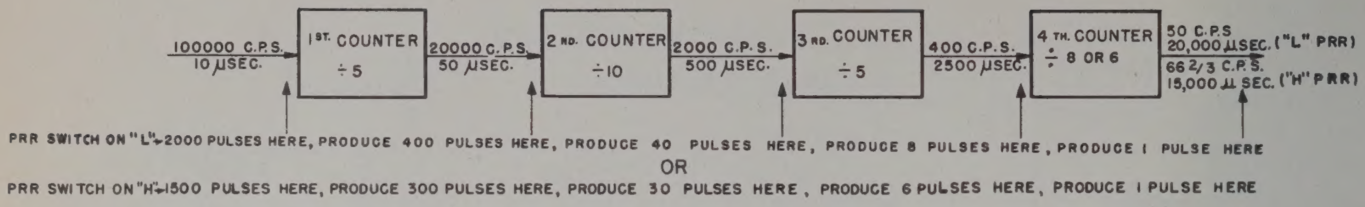

100000 C.P.S.
10 µSEC.
1ST. COUNTER
÷ 5
20000 C.P.S.
50 µSEC.
2 ND. COUNTER
÷ 10
2000 C.P.S.
500 µSEC.
3 RD. COUNTER
÷ 5
400 C.P.S.
2500 µSEC.
4 TH. COUNTER
÷ 8 OR 6
50 C.P.S
20,000 µSEC. ("L" PRR)
66 2/3 C.P.S.
15,000 µ SEC. ("H" PRR)
PRR SWITCH ON "L"→2000 PULSES HERE, PRODUCE 400 PULSES HERE, PRODUCE 40 PULSES HERE, PRODUCE 8 PULSES HERE, PRODUCE 1 PULSE HERE
OR
PRR SWITCH ON "H"→1500 PULSES HERE, PRODUCE 300 PULSES HERE, PRODUCE 30 PULSES HERE, PRODUCE 6 PULSES HERE, PRODUCE 1 PULSE HERE

Figure 4-16—Counter Chain Frequencies, Normal Operation

pulse, which is once during each 40 produced by the Second Counter, a portion (3 times the output pulse of First Counter in this case) is fed back to the Second Counter by means of the Feed-Back circuit. This charge placed on the Second Counter storage capacitor remains in the ordinary way until increased by succeeding pulses from the First Counter. Thus the effect of the feed-back pulse in this case is to raise the starting level of the Second Counter from ground to a point three First Counter pulse-units above ground; in other words it will only require 7 (rather than 10 as in the case with no feed-back) pulses from the First Counter to produce an output pulse from the Second Counter and the Second Counter will fire three steps (of 50 microseconds each) earlier than with no feed-back. As a result, the interval between the previous Second Counter output pulse and the output pulse now produced is only 350 microseconds rather than the normal 500 microseconds obtained with no feed-back.

It should be noted that only the interval following

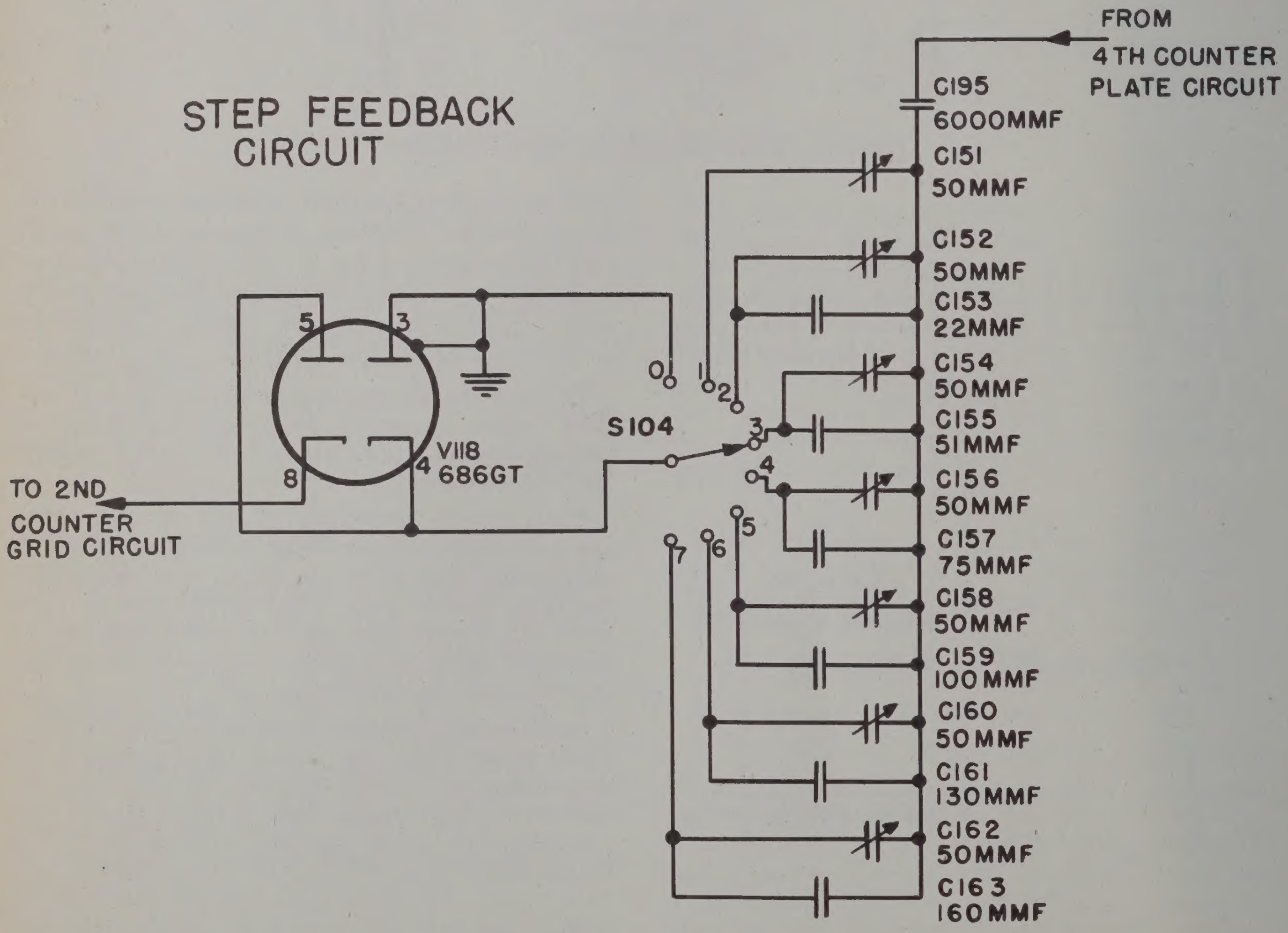

STEP FEEDBACK CIRCUIT
FROM 4TH COUNTER PLATE CIRCUIT
C195
6000MMF
C151
50MMF
C152
50MMF
C153
22MMF
C154
50MMF
C155
51MMF
C156
50MMF
C157
75MMF
C158
50MMF
C159
100MMF
C160
50MMF
C161
130MMF
C162
50MMF
C163
160MMF
S104
0
1
2
3
4
5
6
7
5
3
8
4
V118
6B6GT
TO 2ND COUNTER GRID CIRCUIT

Figure 4-17—Step Feed-Back Circuit

every 40th output pulse of the Second Counter will be shortened in the manner described; all of the other 39 intervals will be of the normal 500 microsecond duration because the short interval is produced only when the Fourth Counter fires.

The Third Counter, which has received the shortened interval from the Second Counter will have a corresponding short interval between two of its output pulses. This interval will also be 150 microseconds short, and when conducted to the Fourth Counter, will produce a 150 microseconds shorter interval in its output.

It can be seen, therefore, that the output intervals from the Fourth Counter will be shortened to 19,850 microseconds as compared with the normal 20,000 microseconds obtained without feed-back. Thus the output frequency of the Fourth Counter will be 1,000,000 divided by 19,850 or approximately 50 3/8 cycles per second. In a similar manner the various positions of the STATION switch S104 (Fig. 4-17) will feed back charges equal in magnitude to 1, 2, 3, 4, 5, 6, or 7 First Counter pulses, as indicated by similar numbers on the switch positions. The available output frequencies of the Fourth Counter for the different settings of the station switch may be tabulated as follows (with the PRR switch turned to L):

Station Selector Switch Position	Time Interval Between Fourth Counter Output Pulses	Approximate Frequency of Fourth Counter Output C.P.S.	Approximate Corresponding Pulse Recurrence Rate, Pulses Per Sec.
0	20.000 u sec.	50	25
1	19,950	50 1/8	25 1/16
2	19,900	50 2/8	25 2/16
3	19,850	50 3/8	25 3/16
4	19,800	50 4/8	25 4/16
5	19,750	50 5/8	25 5/16
6	19,700	50 6/8	25 6/16
7	19,650	50 7/8	25 7/16

Models with the PRR switch installed have an additional family of output frequencies as tabulated below; switch turned to H:

Station Selector Switch Position	Time Interval Between Fourth Counter Output Pulses	Approximate Frequency of Fourth Counter Output C.P.S.	Approximate Corresponding Pulse Recurrence Rate, Pulses Per Sec.
0	15,000 u sec.	66 6/9	33 3/9
1	14,950	66 8/9	33 4/9
2	14,900	67 1/9	33 5/9
3	14,850	67 3/9	33 6/9
4	14,800	67 5/9	33 7/9
5	14,750	67 7/9	33 8/9
6	14,700	68	34
7	14,650	68 2/9	34 1/9

b. TIME CORRECTOR.—(The following explanation is based upon the L basic PRR, operation on the H PRR will then be obvious.) It has been shown that the effect of feedback is to produce a "short" output interval from the Second Counter immediately following a Fourth Counter output pulse, and corresponding short intervals from the Third and Fourth Counters. The output pulses from the Second and Third Counters are used to trip the delay multivibrators at the end of their delay periods, and if the output pulses from the Fourth Counter were used to trip the multivibrators at the beginning of these delays, the delay interval would necessarily vary with each setting of the STATION switch. The variable delay period would tend to produce instability in the multivibrators. Therefore, the Time Corrector is introduced to take up the time of the "short" output interval from the Second Counter and form a time reference point for following circuits. This is best demonstrated by Fig. 4-19 where the interval between Fourth Counter pulses is shown to include all of the Second Counter pulses which occur during the period. The intervals between these 40 pulses are each 500 microseconds, except the first interval following the coincident pulses from the Second and Fourth Counters, as at A (Fig. 4-19). This first interval varies between 150 and 500 microseconds depending upon the STATION switch position, and the resulting Fourth Counter interval will vary from 19,650 to 20,000 microseconds correspondingly; the Time Corrector is also used to initiate the slow sweep (Sweep Speed 1), and the "short" or variable interval is blanked out by the blanking circuits to be described later. Therefore, an incidental result of the Time Corrector is to make the slow trace length independent of the STATION switch position; the trace length is always 19,500 microseconds (on the L PRR). The action of the circuit will now be described in detail.

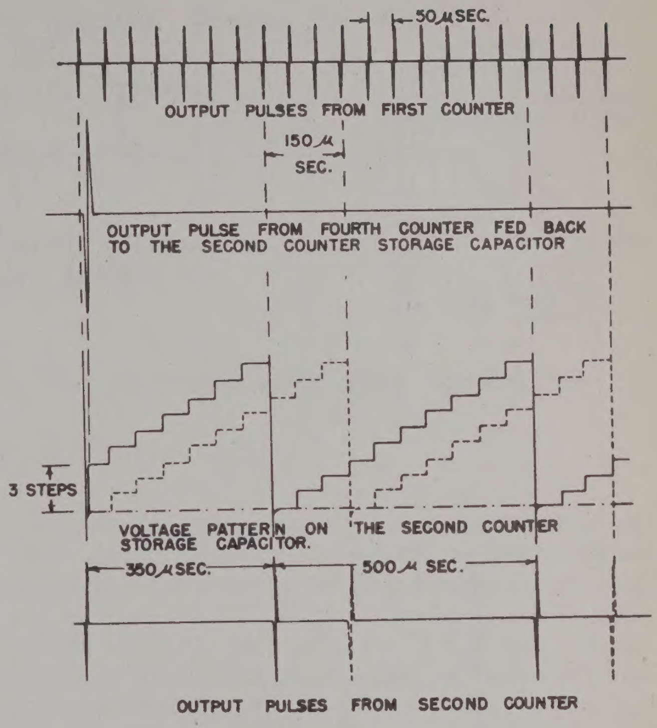

50 μ SEC.
OUTPUT PULSES FROM FIRST COUNTER
150 μ SEC.
OUTPUT PULSE FROM FOURTH COUNTER FED BACK TO THE SECOND COUNTER STORAGE CAPACITOR
3 STEPS
VOLTAGE PATTERN ON THE SECOND COUNTER STORAGE CAPACITOR.
350 μ SEC.
500 μ SEC.
OUTPUT PULSES FROM SECOND COUNTER

Figure 4-18—Step Feed-Back Waveforms

The Time Corrector, Fig. 4-20, is built around an Ec-

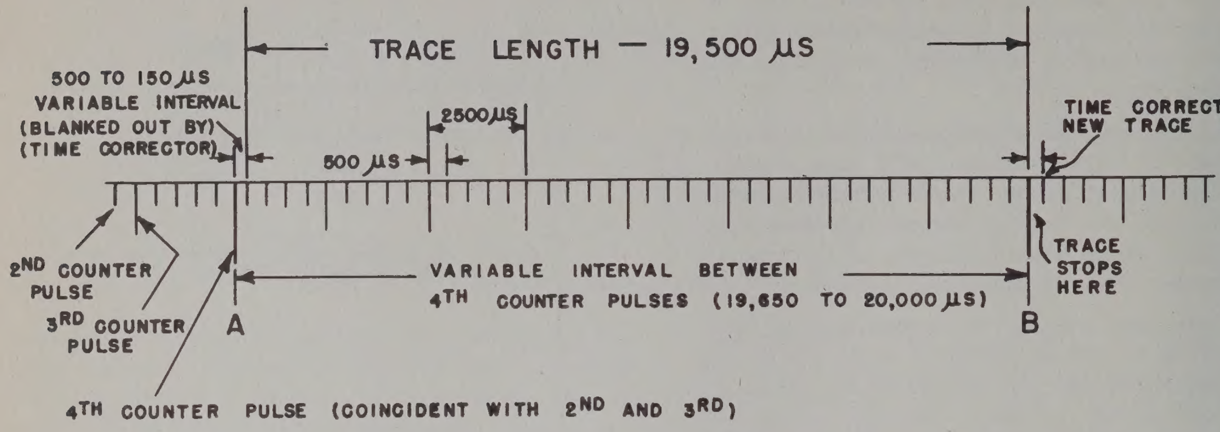


Figure 4-19—Time Intervals on the Slow Trace

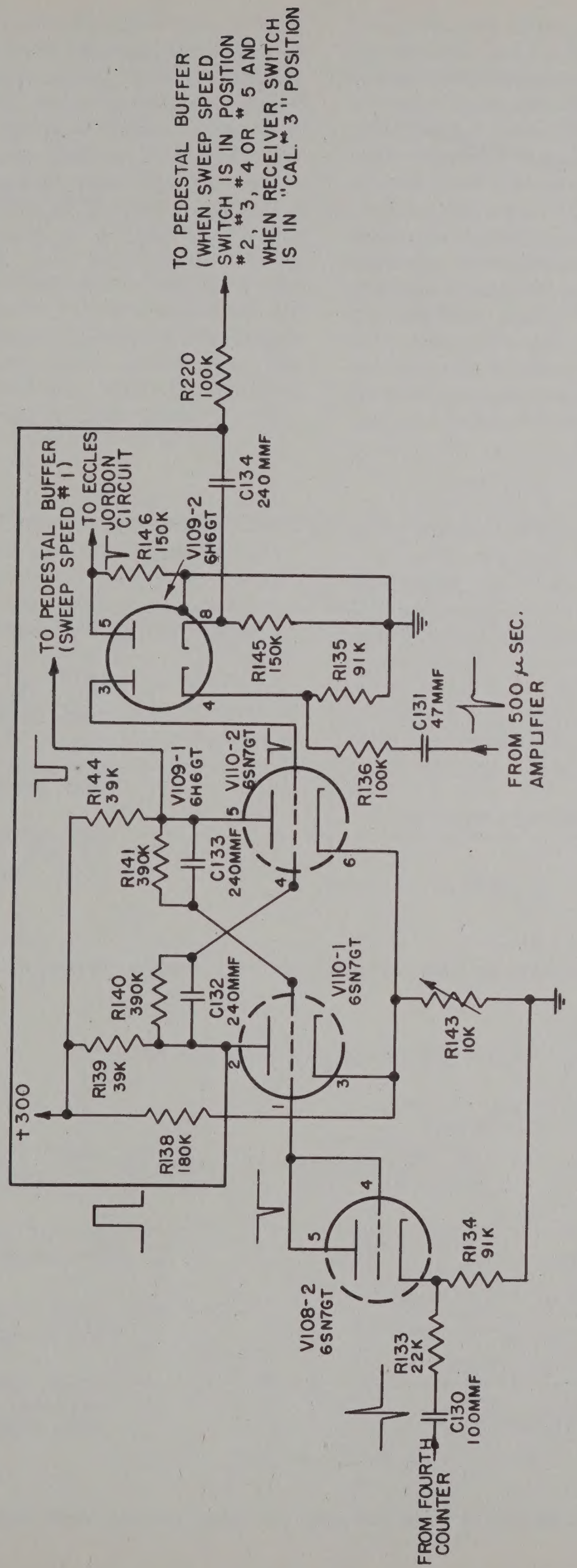
cles-Jordan circuit which consists of two triodes, cross-coupled so that an increase in conductivity of either tube increases the negative grid bias of the other; conversely, a decrease in conductivity of either tube decreases the negative grid bias of the other tube. The grid bias on the tubes is the difference between the cathode-to-ground and grid-to-ground potentials. The cathode-to-ground voltage for both tubes is the voltage across the cathode bias resistor R143. This voltage is a function of the sum of the current through R138 to the 300 v. supply and the current through the tubes. The grid-to-ground voltage on V110-1 (grid No. 1) is determined first by the plate voltage on V110-2 (plate No. 5) and second by the voltage divider circuit between plate 5 and ground consisting of R141 and the tube V108-2 with its cathode resistor R134. Similarly, the grid-to-ground voltage on V110-2 (grid No. 4) is determined by the plate voltage on V110-1 (plate No. 2) and the divider R140 and the tube V109-1 with its resistor R135 to ground. The plate voltage on each tube is a function of the current through the tube. A high current through a tube gives a high voltage drop across its plate resistor (R139 or R144), and a resulting low plate voltage. No current through a tube means that only the bleeder current for the grid bias flows through the plate resistor, and the plate is practically at supply voltage.

Assume that: (1) both tube sections start to conduct current when voltage is first applied to the circuit; (2) that resistances are identical; (3) but due to slight differences in the two sections of the tube that V110-1 conducts more current than V110-2. The plate voltage of V110-1 will be slightly lower than the plate voltage of V110-2. Because plate voltage on one tube determines grid voltage on the other tube, the grid of V110-2 will be at a slightly lower potential than the grid of V110-1, and tube V110-2 will conduct still less current. This will increase the plate voltage of V110-2 and simultaneously increase the grid voltage on V110-1, which will conduct more current. This is obviously a cumulative process and will continue very rapidly until the current through V110-1 and R139 is sufficient to lower the plate voltage of V110-1 and hence the grid voltage of V110-2 to cut-off. The plate voltage of the non-conducting tube will now become stable at very nearly supply voltage, and the grid of the conducting tube will be fixed at some lower potential determined by its voltage dividing circuit. This is a stable condition and will remain until the circuit is acted upon by an external influence which is strong enough to start tube V110-2 conducting again. When V110-2 begins to conduct again it will cause the reverse of the process described above, and very rapidly cut-off tube V110-1 and drive tube V110-2 to a full plate current. One tube will always be conducting and the other cut-off.

The external influence used to trip this circuit is a voltage applied to the grid of each tube. The purposes of the Time Corrector is to furnish a timing reference between the time of a Fourth Counter output pulse and the first Second Counter pulse following it. By tripping the circuit one way with one of these pulses and the other way with the other pulse the square wave, or block, of voltage at the plate of either tube contains the desired timing. The output from one tube is used for blanking the slow sweep and the output from the other is used for tripping other circuits.

The output timing pulse from the Fourth Counter passes through capacitor C130 to the voltage dividing circuit R133-R134 and to the cathode of tube V108-2 (Fig. 4-20). The tube is connected as a diode and acts as a clipper, passing only the negative portion of the pulse to the grid of V110-1. This pulse cuts off tube V110-1 and makes tube V110-2 conduct.

The output pulse from the Second Counter passes through capacitor C131 to the voltage dividing circuit R136-R135 and to the cathode (pin No. 4) of the diode V109-1. This tube also acts as a clipper, passing only the negative portion of the pulse to the grid of tube V110-2, which cuts off V110-2 and makes V110-1 conduct. Additional Second Counter pulses conducted to the grid of V110-2 have no effect because the tube is already cut-off.


TO PEDESTAL BUFFER (WHEN SWEEP SPEED SWITCH IS IN POSITION #2, #3, #4 OR #5 AND WHEN RECEIVER SWITCH IS IN "CAL. #3" POSITION
R220
100K
C134
240 MMF
TO PEDESTAL BUFFER (SWEEP SPEED #1)
TO ECCLES JORDON CIRCUIT
R146
150K
V109-2
6H6GT
5
3
8
4
R145
150K
R135
91K
C131
47MMF
FROM 500 μ SEC. AMPLIFIER
R144
39K
V109-1
6H6GT
V110-2
6SN7GT
R136
100K
R141
390K
C133
240MMF
5
4
6
R140
390K
C132
240MMF
V110-1
6SN7GT
R143
10K
+300
R139
39K
2
1
3
R138
180K
4
5
R134
91K
V108-2
6SN7GT
R133
22K
C130
100MMF
FROM FOURTH COUNTER

K: THOUSANDS OF OHMS

Figure 4-20—Time Corrector Circuit Diagram

The circuit will, therefore, remain in this position until the next Fourth Counter pulse is received. Although a Fourth Counter and a Second Counter pulse arrive almost simultaneously, the Fourth Counter pulse occurs approximately 6 microseconds later than the other, and will trip the circuit. The Fourth Counter negative pulse on the grid of V110-1 will reduce plate current and cause a sharp increase in plate voltage. This increase in plate voltage is conducted to the grid of V110-2 and raises the grid voltage above cut-off. The tube starts to conduct, the plate voltage drops, and an additional negative charge is placed on the grid of V110-1, which cuts it off until the next Second Counter pulse. The result is a positive square wave or block of voltage at the plate of V110-1 (and conversely a negative block at the plate of V110-2), whose duration is between 500 and 150 microseconds, depending upon the amount of feed-back. Figs. 4-21 and 4-22 show the relationship between the pulses received and the voltage output from V110-2. This voltage is reduced to low impedence by the Pedestal Buffer and used for blanking the oscilloscope when the SWEEP SPEED switch is on 1. The voltage from tube V110-1 is fed through the Pedestal Buffer and used for blanking when the RECEIVER switch is on CAL 1 and the SWEEP SPEED switch is on any position except 1. After "differentiating" and "clipping" the output of this tube is also used to trip the 25 cycle Eccles-Jordan Square Wave Generator V111. Differentiating was previously described in the general discussion of the Theory of Operation. In this case the output wave from V110-1 is differentiated by C134 and R145 and the negative going "pip" is passed through tube V109-2 to the 25 cycle

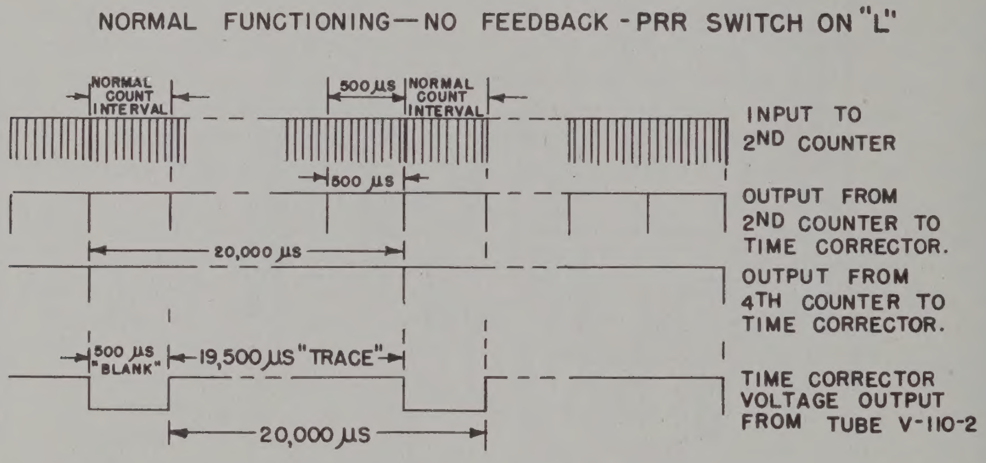

NORMAL FUNCTIONING—NO FEEDBACK - PRR SWITCH ON "L"
NORMAL COUNT INTERVAL
500 µS
NORMAL COUNT INTERVAL
INPUT TO 2ND COUNTER
500 µS
OUTPUT FROM 2ND COUNTER TO TIME CORRECTOR.
20,000 µS
OUTPUT FROM 4TH COUNTER TO TIME CORRECTOR.
500 µS "BLANK"
19,500 µS "TRACE"
TIME CORRECTOR VOLTAGE OUTPUT FROM TUBE V-110-2
20,000 µS

Figure 4-21—Effects of Time Corrector on Trace Length, Normal Operation

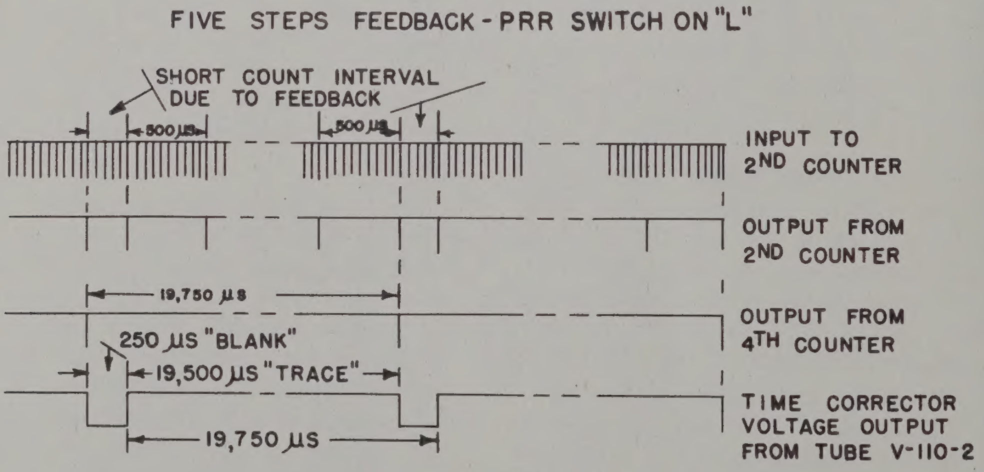

FIVE STEPS FEEDBACK - PRR SWITCH ON "L"
SHORT COUNT INTERVAL DUE TO FEEDBACK
500 µS
500 µS
INPUT TO 2ND COUNTER
OUTPUT FROM 2ND COUNTER
19,750 µS
OUTPUT FROM 4TH COUNTER
250 µS "BLANK"
19,500 µS "TRACE"
TIME CORRECTOR VOLTAGE OUTPUT FROM TUBE V-110-2
19,750 µS

Figure 4-22—Effects of Time Corrector on Trace Length, With Feed-Back

Eccles-Jordan Square Wave generator.

The received waves and the output pulses from tube V109-2, when the PRR switch is on L, are represented in Figs. 4-21 and 4-22. It should be noticed from these drawings that the output pulse from V109-2 occurs only at the start of the regular, or standardized time interval; i.e. the 19,500 microsecond period when the PRR switch is on L or 14,500 microsecond period when it is on H.

i. ECCLES-JORDAN SQUARE WAVE GENERATOR.—The Eccles-Jordan Square Wave Generator is the basic circuit of the Time Corrector just described. It consists of two triodes, cross-coupled so that when one tube is conducting the other is cut-off (Fig. 4-23). The only difference between the Time Corrector and this circuit is that the tripping pulse (the output from the Time Corrector) is simultaneously impressed on the grids of both tubes.

The cathode bias is obtained from the tube current passing through resistors R148 and R190 in addition to a small amount of bleeder current supplied by R150. The grid-to-ground voltage of each tube is determined by the plate voltage of the other tube, plus its own voltage dividing grid circuit. The sharp negative pulse from the Clipper tube V109-2 is coupled to the grid of V111-1 through C138 and R154, and to the grid of V111-2 through C139 and R155. Each time the negative pulse is received it trips the circuit because the pulse falling on the grid of the tube which is already cut-off has no effect, but on the grid of the conducting tube, it causes a sharp rise in plate voltage. This puts a positive charge on the grid of the cut-off tube and it starts to conduct. Although some of this positive charge will be coupled to the other grid through R154, C138, C139 and R115, it will be small compared to the charge transmitted to the grid by the change in plate voltage.

Each time a pulse is received it will trip the circuit and, since this change from conducting to cut-off takes only about 1 microsecond, the output from either tube will be a square wave. The frequency will be one-half the repetition rate of the Fourth Counter pulses. The wave of plate voltage is the last one in Figs. 4-23 and 4-24 and shows the relationship between this output wave and the Fourth Counter and Time Corrector output voltages. The plate voltage waves of the two tubes are identical, but are 180° out of phase.

The voltage output wave from tube V111-1 is amplitude controlled by the Trace Shift Mixer and "SWEEP SPEED" switch and then put on the vertical deflection plates of the Oscilloscope. The horizontal sweep circuit for the Oscilloscope slow trace is triggered by the output from the Time Corrector at a rate of 50 (or 66 2/3) traces per second (depending upon the PRR switch position). This is twice the 25 (or 33 1/3) c.p.s. frequency of the Eccles-Jordan Square Wave Generator output, so the second trace will be vertically displaced from the first. The third trace will coincide with the first, the fourth with the second, etc.

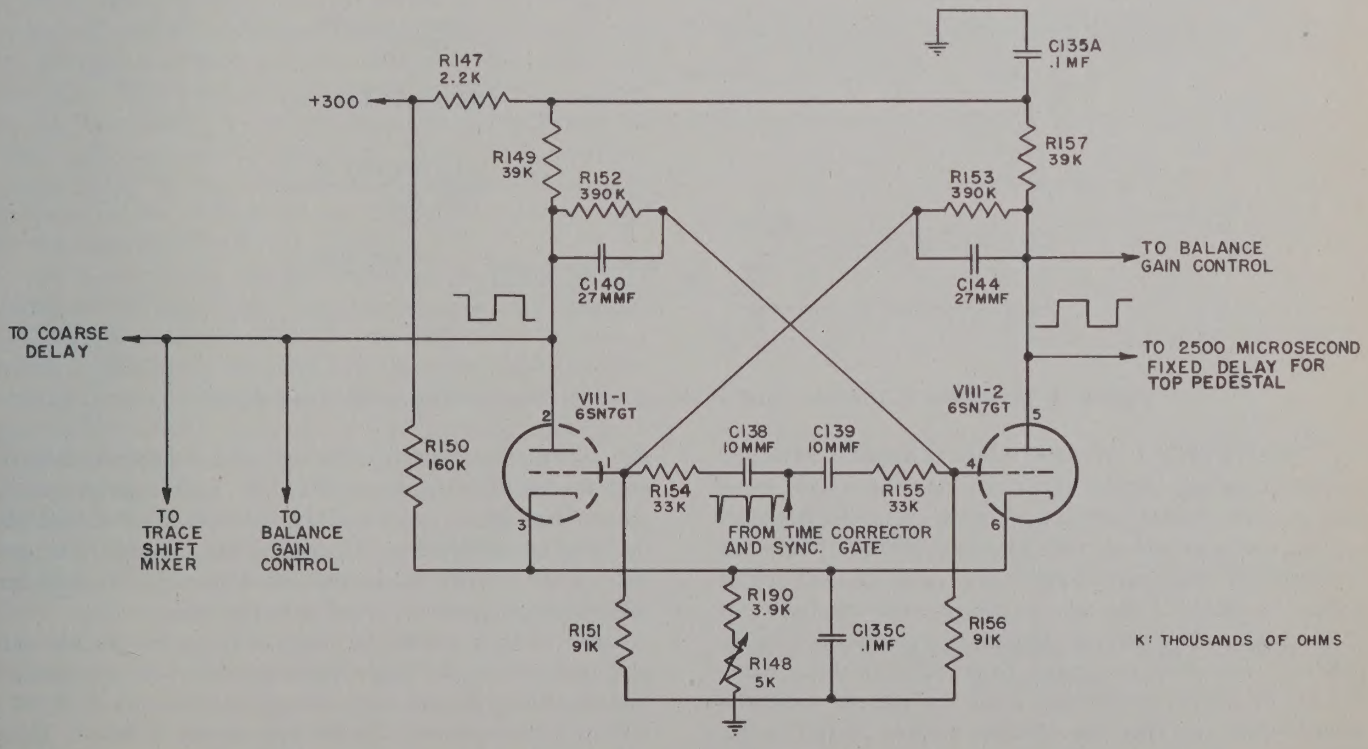

C135A
.1MF
R147
2.2K
+300
R149
39K
R152
390K
R153
390K
R157
39K
TO BALANCE
GAIN CONTROL
C140
27MMF
C144
27MMF
TO COARSE
DELAY
TO 2500 MICROSECOND
FIXED DELAY FOR
TOP PEDESTAL
V111-1
6SN7GT
V111-2
6SN7GT
2
5
C138
10MMF
C139
10MMF
R150
160K
1
4
R154
33K
R155
33K
TO
TRACE
SHIFT
MIXER
TO
BALANCE
GAIN
CONTROL
3
6
FROM TIME CORRECTOR
AND SYNC. GATE
R190
3.9K
R151
91K
C135C
.1MF
R156
91K
K: THOUSANDS OF OHMS
R148
5K

Figure 4-23—Eccles-Jordan Square-Wave Generator Circuit Diagram

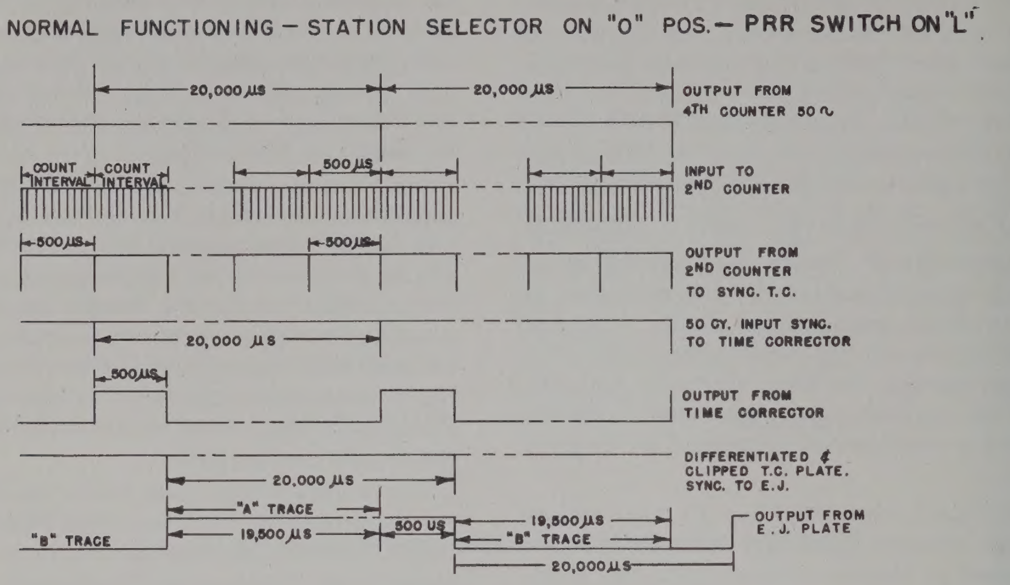

NORMAL FUNCTIONING — STATION SELECTOR ON "O" POS.— PRR SWITCH ON "L"
20,000 µs
20,000 µs
OUTPUT FROM 4TH COUNTER 50 ∿
COUNT INTERVAL
COUNT INTERVAL
500 µs
INPUT TO 2ND COUNTER
500 µs
500 µs
OUTPUT FROM 2ND COUNTER TO SYNC. T.C.
20,000 µs
50 CY. INPUT SYNC. TO TIME CORRECTOR
500 µs
OUTPUT FROM TIME CORRECTOR
DIFFERENTIATED & CLIPPED T.C. PLATE. SYNC. TO E.J.
20,000 µs
"A" TRACE
"B" TRACE
19,500 µs
500 US
19,500 µs
"B" TRACE
OUTPUT FROM E.J. PLATE
20,000 µs

Figure 4-24—Time Corrector and Eccles-Jordan Waveforms for Normal Operation

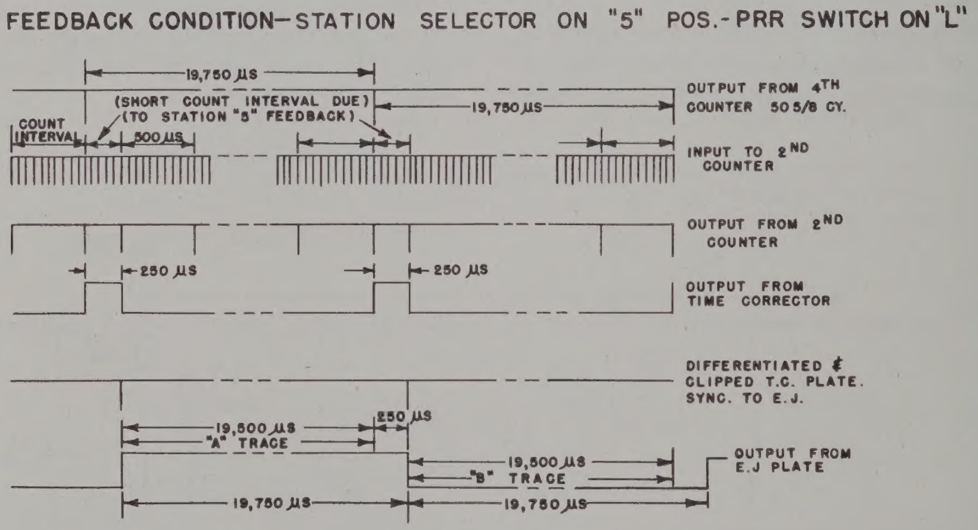

FEEDBACK CONDITION—STATION SELECTOR ON "5" POS.-PRR SWITCH ON "L"
19,750 µs
(SHORT COUNT INTERVAL DUE) (TO STATION "5" FEEDBACK)
19,750 µs
OUTPUT FROM 4TH COUNTER 50 5/8 CY.
COUNT INTERVAL
500 µs
INPUT TO 2ND COUNTER
OUTPUT FROM 2ND COUNTER
250 µs
250 µs
OUTPUT FROM TIME CORRECTOR
DIFFERENTIATED & CLIPPED T.C. PLATE. SYNC. TO E.J.
250 µs
19,500 µs
"A" TRACE
19,500 µs
"B" TRACE
OUTPUT FROM E.J PLATE
19,750 µs
19,750 µs

Figure 4-25—Time Corrector and Eccles-Jordan Waveforms with Feed-Back

j. TRACE SHIFT MIXER AND MARKER MIXER.—The preceding section explained that the square wave output of the Eccles-Jordan generator is used for separating the traces on the cathode ray tube. Properly reduced in amplitude, the square wave is impressed on the vertical deflection plates of the tube to produce the displacement of the beam. The various time markers are also used to produce vertical displacements in the tube, so these markers, at the proper amplitude, must be "mixed" with the square wave and then the combined wave passed to the deflection plates.

The output from the First, Second, and Third Counters are first "mixed", "clipped", reduced to low impedence, and then mixed with the trace separation which appears on the cathode of V117-2. Each counter pulse passes through its own resistor and capacitor circuit to the grid of the Marker Mixer tube (Fig. 4-26). The resistor and capacitor values were chosen to give each pulse the proper magnitude, relative to the others.

Grid current, caused by the marker pulses across the grid-leak resistor R175, provides several volts of negative bias on the grid, and the voltage divider circuit R178, R179 provides about 15 volts bias on the cathode. This holds the tube beyond cut-off until a positive pulse is received on the grid. When a positive pulse is received, the tube conducts and a voltage is set up across R177.

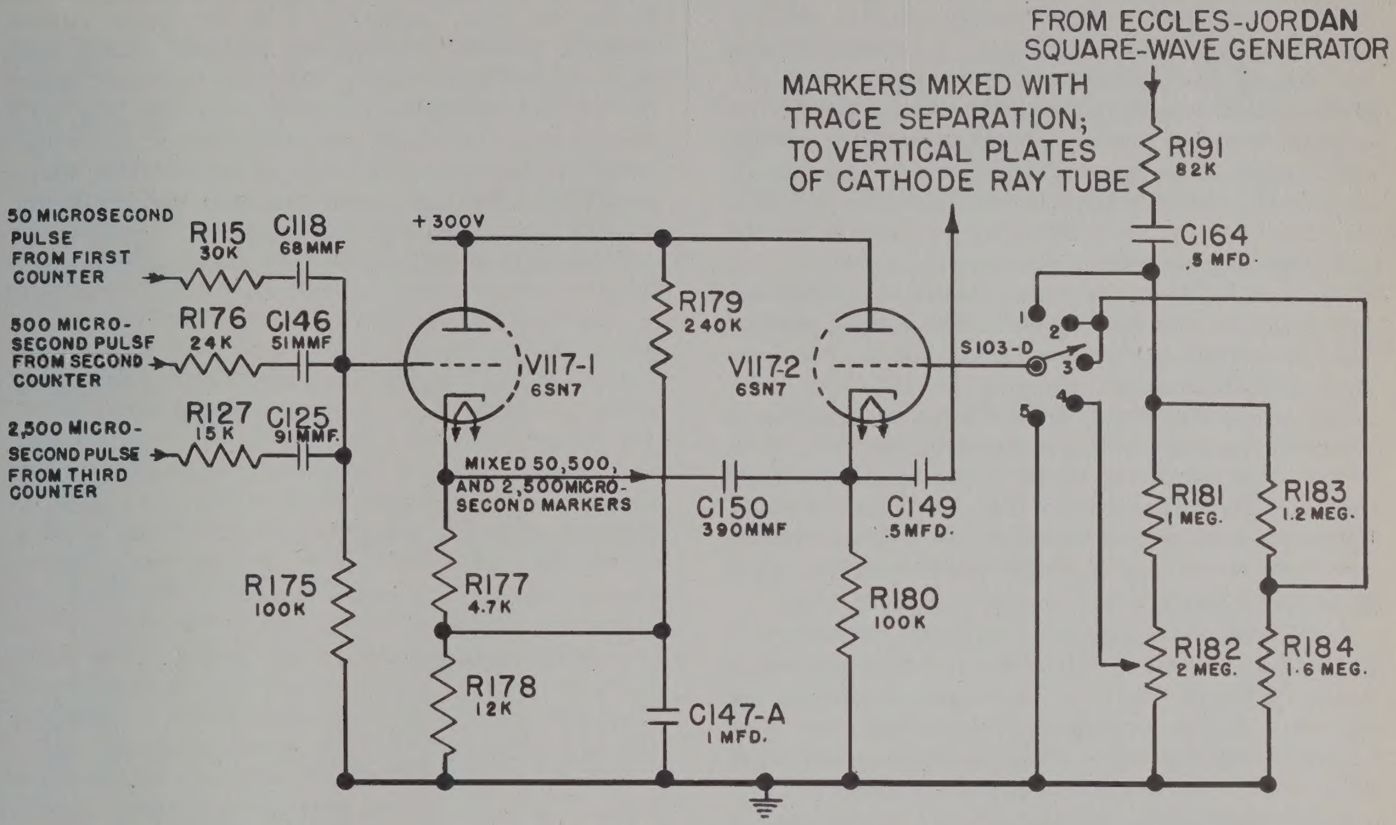

FROM ECCLES-JORDAN SQUARE-WAVE GENERATOR
MARKERS MIXED WITH TRACE SEPARATION; TO VERTICAL PLATES OF CATHODE RAY TUBE
R191 82K
C164 .5 MFD.
50 MICROSECOND PULSE FROM FIRST COUNTER
R115 30K
C118 68MMF
+300V
500 MICRO-SECOND PULSF FROM SECOND COUNTER
R176 24K
C146 51MMF
2,500 MICRO-SECOND PULSE FROM THIRD COUNTER
R127 15K
C125 91MMF.
V117-1 6SN7
R179 240K
V117-2 6SN7
S103-D
1
2
3
4
5
MIXED 50,500, AND 2,500MICRO-SECOND MARKERS
C150 390MMF
C149 .5MFD.
R181 1 MEG.
R183 1.2 MEG.
R175 100K
R177 4.7K
R180 100K
R182 2 MEG.
R184 1.6 MEG.
R178 12K
C147-A 1 MFD.

Figure 4-26—Marker Mixer and Trace Shift Mixer Circuit Diagram

C147-A serves as a by-pass for R178, but R177 is not by-passed and an additional voltage drop occurs across it. This gives a sharp positive voltage at the cathode of the tube. This voltage is produced by just the positive tip of the received pulse which caused plate current to flow, and is very short in duration. These short, positive-going pulses at the cathode of the marker Mixer are coupled to the cathode of the Trace Shift Mixer tube by the capacitor C150 (Fig. 4-26).

The output from the Eccles-Jordan generator is first corrected for amplitude, then impressed on the grid of the cathode follower V117-2. At each different sweep speed, a different trace shift voltage is required for separating the traces the proper amount. The switch S103-D and resistors R181, 182, 183, 184 (Fig. 4-26) make possible the selection of the desired amplitude of voltage or trace separation. In addition, position four of the SWEEP SPEED switch is connected to the center tap of the potentiometer R182 and makes possible a much more accurate adjustment. This adjustment is used to set the trace separation at a point where the 50 microsecond markers of the top trace just touch the tops of the 10 microsecond markers of the bottom trace on the fastest (160 microsecond) sweep. The fifth switch position must bring the traces together so that the leading edges of two received pulses can be superimposed. The switch ties the grid of V117-2 to ground, and prevents the coupling of any signal from the Eccles-Jordan generator to the Mixer tube.

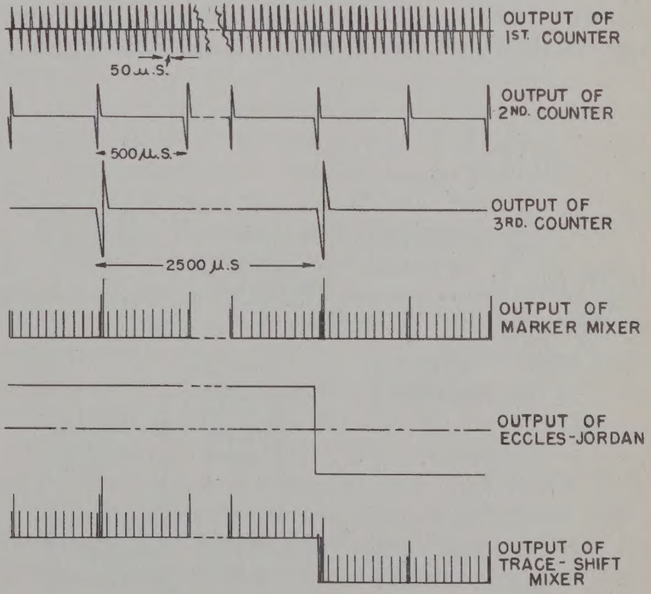

OUTPUT OF 1ST. COUNTER
50 µ.S.
OUTPUT OF 2ND. COUNTER
500 µ.S.
OUTPUT OF 3RD. COUNTER
2500 µ.S
OUTPUT OF MARKER MIXER
OUTPUT OF ECCLES-JORDAN
OUTPUT OF TRACE-SHIFT MIXER

Figure 4-27—Marker Mixer and Trace Shift Mixer Waveforms

Cathode bias for the Trace Shift Mixer tube, V117-2, is obtained by R180 (Fig. 4-26). When a positive signal is received on the grid, current through the tube increases; when a negative signal is received, current decreases. This gives a cathode voltage which is identical to the incoming square wave in phase position and shape, but slightly less in amplitude. The signals from the Marker Mixer which are coupled to the cathode of this tube are superimposed on the square wave of voltage at this point. C149, the coupling capacitor to the cathode ray tube, is relatively large in order to carry faithfully the 25 (or 33 1/3) cycle square waves, with the 50, 500 and 2500 microsecond positive pips on it.

The outputs from the three counters, corrected for amplitude, are shown in Fig. 4-27. The positive parts of these pulses, mixed, are also shown just as they come from the Marker Mixer.

The square wave from the Eccles-Jordan generator is shown in Fig. 4-27 as it is received by the Trace Shift Mixer. The last voltage wave shown is the combined output of the circuit. Notice that the pips, or markers, all are positive and will therefore give a downward displacement when coupled to the lower deflection plate of the cathode ray tube.

k. PHASE SET AND TEN MICROSECOND MARKER.—When the Receiver switch is turned to either "ON", or "OFF", 10 microsecond markers are impressed directly on the top, vertical deflection plate of the cathode ray tube. When the switch is turned to either CAL. 1 or CAL. 2 the markers are removed.

It is necessary that every fifth 10 microseconds marker coincide in time with a 50 microsecond marker to accurately estimate unit microseconds when making a reading. In other words, a 50 microsecond marker must be superimposed accurately on every fifth 10 microsecond marker. Although both the Ten Microsecond Marker tube and the First Counter (which produces the 50 microsecond markers) are driven directly from the Crystal Buffer, the First Counter and Marker Mixer circuits introduce a small delay between the steep, leading edge of the Crystal Buffer voltage wave and the First Counter (50 microsecond marker) output pulses. (See Fig. 4-9.) This delay is a little over three microseconds, and a similar delay must also be introduced into the Ten Microsecond Marker output pulses. The Phase Set circuit (Fig. 4-28) is used to produce this delay.

A 3.33 microsecond delay of the 10 microsecond mark-

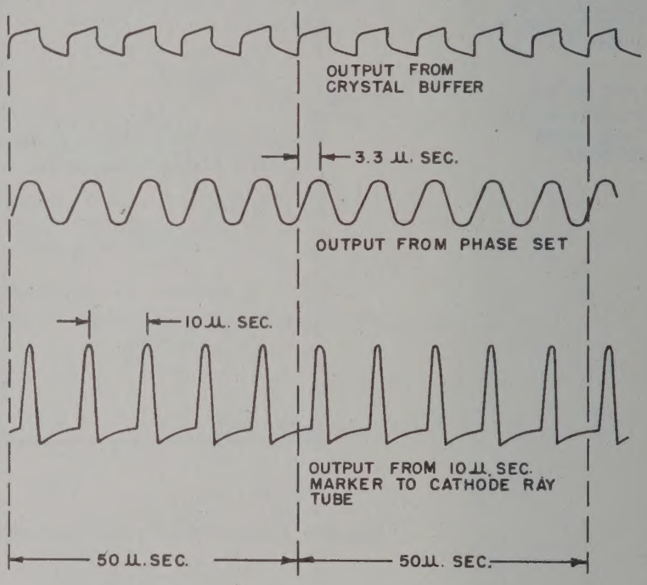


Figure 4-29—Phase Set and Ten Microsecond Marker Waveforms

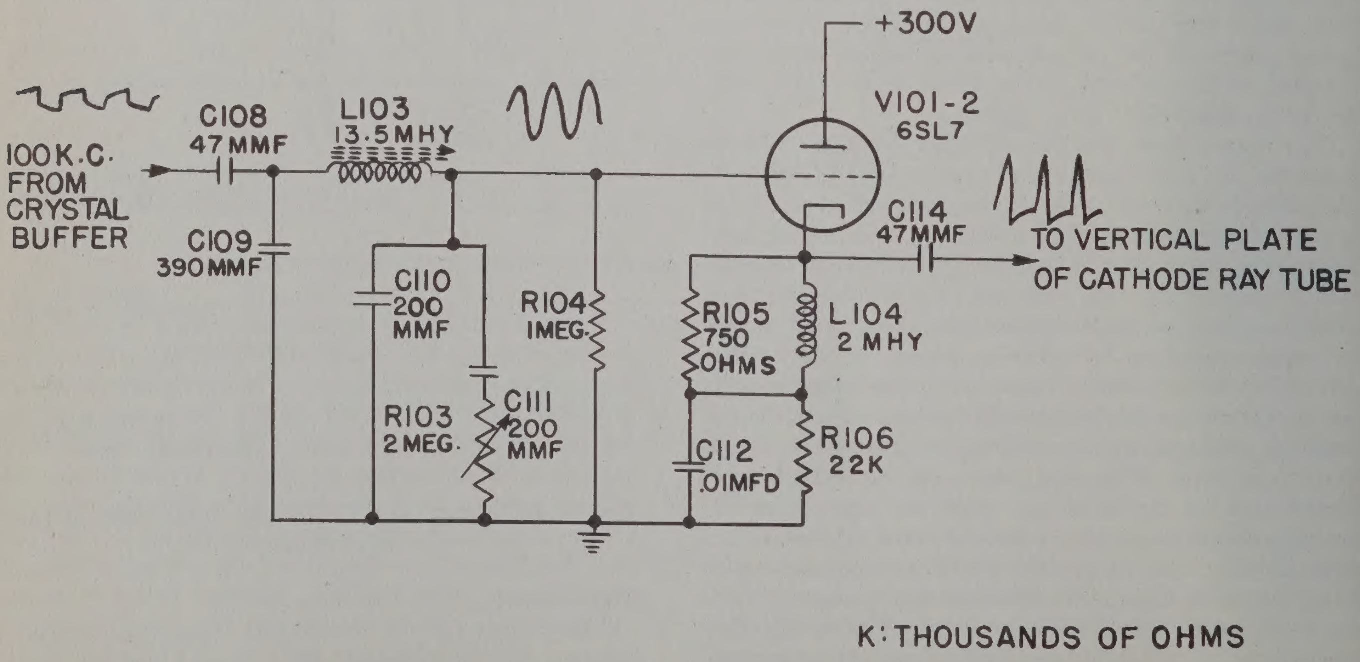


Figure 4-28—Phase Set and Ten Microsecond Marker Circuit Diagram

ers amounts to 120 degrees ($\frac{3.33}{10}$x360°), which is approximately the delay produced by the First Counter. The delay time of the Phase Set must equal this value and at the same time be variable to compensate for small changes in circuit constants.

The output from the Crystal Buffer plate is coupled to the Phase Set circuit by means of C108 (Fig. 4-28). The Phase Set circuit consists of a low-pass Pi-section filter, C109, L103, C110, C111, and R103. The coupling capacitor C108 is made small to prevent overloading of the Crystal Buffer. For the same reason, the input capacitor of the Pi-section, C109, is also made small, giving the circuit a high impedance. The inductance L103 is of the powdered-iron-core type, and variable to allow some tuning of the circuit to take up manufacturing tolerances. The output capacitance is obtained from C110 and C111 in parallel. The high resistance potentiometer in seres with C111 makes it possible to vary the total output capacitance over a wide range for further tuning. When the resistance is zero, the full 200 mmf. of C111 is effectively in the circuit. When the potentiometer is all in, giving two megohms, C111 is effectively out of the circuit. This gives a tuning range from about 200 mmf. to 400 mmf. in the output of the Pi-section.

The voltage wave from the Crystal Buffer is as shown at the top of Fig. 4-29. Because the coupling capacitor C108 is small and followed with a Pi-section, tuned filter of high impedance, the wave shape is changed to a sine wave form in passing through, as indicated by the wave shapes on Fig. 4-28. In addition, when the Phase Set circuit is tuned to exactly crystal frequency, it imparts a 180 degree phase shift, or delay, to the wave; when it is tuned to a higher frequency it imparts a smaller delay.

One characteristic of the low-pass filter is that in the pass-band the output remains constant; i.e., all signals below the critical, or tuned frequency of the filter are passed with equal magnitudes. This also means that the magnitude of a signal of a given frequency will be unchanged by a change in the tuned frequency of the filter, so long as the tuned frequency remains above the signal frequency.

The output from the Phase Set is applied directly to the grid of the Marker tube V101-2 (Fig. 4-28). The resistor R104 has a high value so as to give the tube a grid-leak bias without overloading the filter circuit. This bias is about three volts which adds to the cathode bias.

Cathode bias for the tube is established by R106 and the by-pass condenser C112. This bias is about 20 volts and holds the tube beyond cut-off until the grid is driven positive. When the grid swings to a high enough potential, the tube conducts. This occurs only on the peaks of the grid signal, and the rest of the incoming wave is cut-off. The load for the tube is supplied by L104 which, by means of its stray and distributed capacity, is tuned to about 500 kilocycles. The tube rapidly reaches a peak plate current, and produces a voltage across the coil. If no damping were applied, this voltage would take the form of a decaying 500 kilocycle sine wave. R105 is a damping resistor connected across the terminals of the coil, and its value is chosen to produce critical damping. The output from the circuit will, therefore, be very narrow, positive pulses of voltage separated by ten microseconds as shown in Fig. 4-29. These pulses are coupled directly to the top deflection plate of the cathode ray tube by C114 and produce the small, upward deflections used as 10 microsecond markers.

A comparison of Fig. 4-9 and Fig. 4-29 will show the relationship established between 50 and 10 microsecond markers. Both figures show the output wave of the Crystal Buffer and Fig. 4-9 shows the phase relationship between the Buffer output and the 50 microsecond markers. The markers are produced by just the positive portion of the First Counter output pulse, and may be seen to lag the leading edge of the Crystal Buffer output wave by about 3 microseconds. Fig. 4-29 shows an equivalent lag introduced by the Phase Set circuit, and the resulting 10 microsecond marker pulses.

l. DELAY MULTIVIBRATOR CIRCUITS.—Both of the traces with pedestals and signals are shown in Fig. 4-30. Notice that the A pedestal starts exactly on the first 2500 microsecond marker. The signal on the B trace is shown in three of the many positions in which it might fall, and it must be possible to move the B pedestal under it in any of these positions.

Three delay circuits are used for locating the pedestals, and all three are similar circuits. The A delay time is arbitrarily chosen to space the A pedestal long enough after the start of the trace to give the operator time for observing and stopping signals on it when they drift in from the left. The B delay time must be variable, and so the two B delay circuits are adjustable, one (the Coarse Delay) in steps of 500 microseconds to a total delay time of approximately 12,500 and the other (the Fine Delay) continuously over a minimum range of 550 microseconds. The delay periods from the two B delay circuits are added together to produce the total B delay time.

The Square Wave Generator is used to trigger the delay circuits simultaneous with the start of the traces, the A delay with the start of the A trace and the Coarse Delay wih the start of the B trace. The Coarse Delay triggers the Fine Delay at the end of its period.

m. 2500 MICROSECOND FIXED DELAY MULTIVIBRATOR.—The 2500 Microsecond Fixed Delay for the A pedestal is obtained from a cathode coupled, double triode multivibrator circuit. This circuit (Fig. 4-31) is triggered by the output from the Square Wave Generator. The square wave input passes through the isolating resistor R205 to the differentiating network C172 and R204. As explained previously under Electrical Differentiation, this places a sharp, positive pulse on the grid of V120-1 at the start of each positive-going square wave, and a negative pulse at the end. In this circuit only the positive-going pulse has an effect, as will be explained later.

The cathode bias for both tubes of the circuit (V120, sections one and two) is fixed by the current through

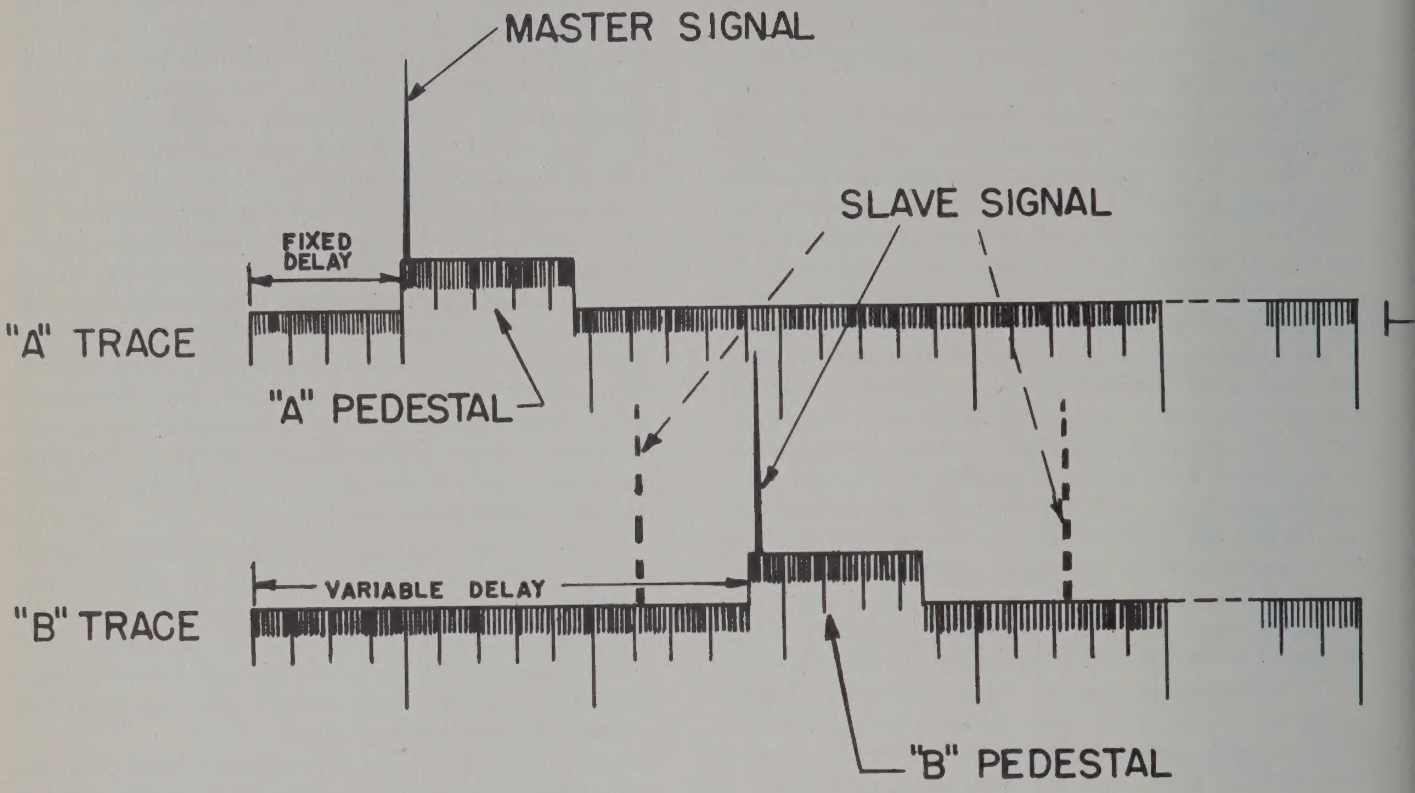


Figure 4-30—Slow Trace, Showing Pedestals and Signals

the common cathode resistor R209. The grid-to-cathode bias on each tube is the difference between its grid-to-ground and cathode-to-ground voltages. The correct operating grid-to-ground voltage of tube V120-1 is obtained by adjusting the tap on R202, which is part of the voltage divider circuit R201, R202, and R203. This voltage is always adjusted to a point that will normally cut off the tube. The grid of tube V120-2 is connected to the positive side of the power supply through the high resistance R207, so it will be at nearly the voltage of the cathode, and this tube will normally conduct.

When the negative pulse from the differentiator C172 is placed on the grid of the non-conducting tube V120-1, it has no effect on the output. A positive pulse, however, swings the grid above cut-off and the tube passes current. A sharp drop in plate voltage is produced due to the current flowing through the load resistor R206. The grid of V120-2, coupled to the plate of V120-1 by means of capacitor C173, receives this negative signal and cuts off V120-2. This tube then remains non-conducting until the negative charge can leak off the grid through the high resistance of R207, the discharge time-constant being determined by C173 and R207.

Only a pulse is used to start tube V120-1 conducting, but once started it cuts off tube V120-2 and the only current through R209 is the current in V120-1. This reduced current lowers the cathode-to-ground potential of the tubes enough so that when the grid of V120-1 returns to its normal voltage after the synchronizing pulse is over, the tube will not be cut off again but will continue to conduct. The circuit will remain in this state, with V120-1 conducting and V120-2 non-conducting, until the negative charge has had time to leak off of the grid of V120-2. When the charge has leaked off and V120-2 starts to conduct again, the increase in current through R209 raises the cathode potential of the tubes giving V120-1 more bias and reducing its plate current. This causes an increase in plate voltage and a positive signal is conducted to the grid of V120-2 by C173. More current flows through V120-2 and R209, increasing the cathode bias still more, etc. This action rapidly cuts off tube V120-1 and brings tube V120-2 up to its zero bias plate current.

Variation of the time delay (the period of non-conductivity of V120-2) may be obtained by adjusting the bias potentiometer R202. This potentiometer determines the normal grid-to-ground voltage of V120-1, and when the tube is conducting, the lower this voltage the less will be the current through the tube. This causes less drop across R206, which when transferred to V110-2 by C173 produces less bias which must be overcome by the charging action of R207. The smaller current through V120-1 will also mean less drop across R209 and a slightly lower cathode-to-ground potential for both

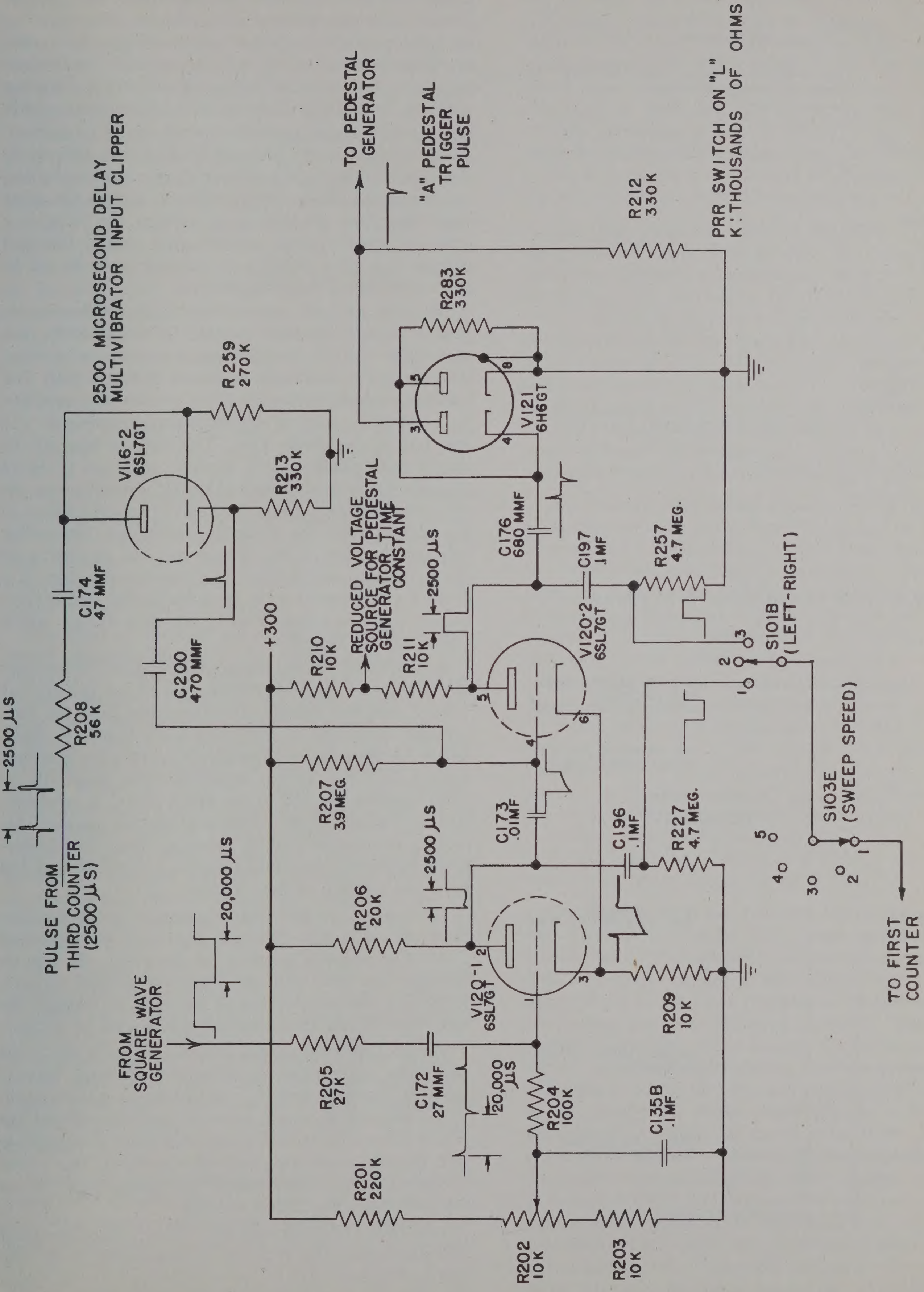

2500 MICROSECOND DELAY
MULTIVIBRATOR INPUT CLIPPER
TO PEDESTAL
GENERATOR
"A" PEDESTAL
TRIGGER
PULSE
PRR SWITCH ON "L"
K: THOUSANDS OF OHMS
PULSE FROM
THIRD COUNTER
(2500 µS)
2500 µS
R208
56 K
C174
47 MMF
V116-2
6SL7GT
R259
270 K
R213
330K
C200
470 MMF
+300
R210
10 K
REDUCED VOLTAGE
SOURCE FOR PEDESTAL
GENERATOR TIME
CONSTANT
R211
10 K
2500 µS
R283
330K
V121
6H6GT
R212
330K
C176
680 MMF
C197
.1 MF
R257
4.7 MEG.
V120-2
6SL7GT
S101B
(LEFT-RIGHT)
FROM
SQUARE WAVE
GENERATOR
20,000 µS
R207
3.9 MEG.
C173
.01 MF
R206
20 K
2500 µS
C196
.1 MF
R227
4.7 MEG.
S103E
(SWEEP SPEED)
TO FIRST
COUNTER
V120-1
6SL7GT
R209
10 K
R205
27 K
C172
27 MMF
20,000 µS
R204
100 K
C135B
.1 MF
R201
220 K
R202
10 K
R203
10 K
1
2
3
4
5
6
8

Figure 4-31—Fixed "A" Delay Multivibrator Circuit Diagram

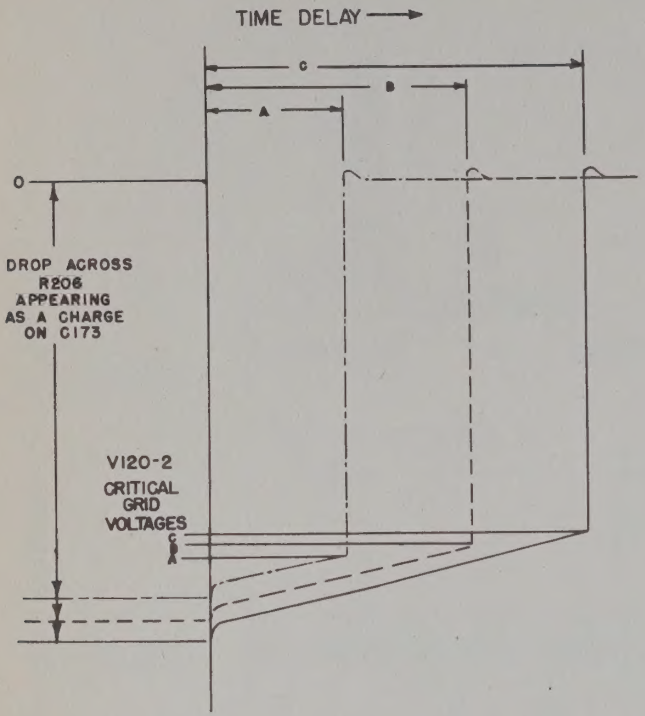

TIME DELAY
C
B
A
0
DROP ACROSS R206 APPEARING AS A CHARGE ON C173
V120-2 CRITICAL GRID VOLTAGES
C
B
A

Figure 4-32—Fixed Delay Grid Voltages

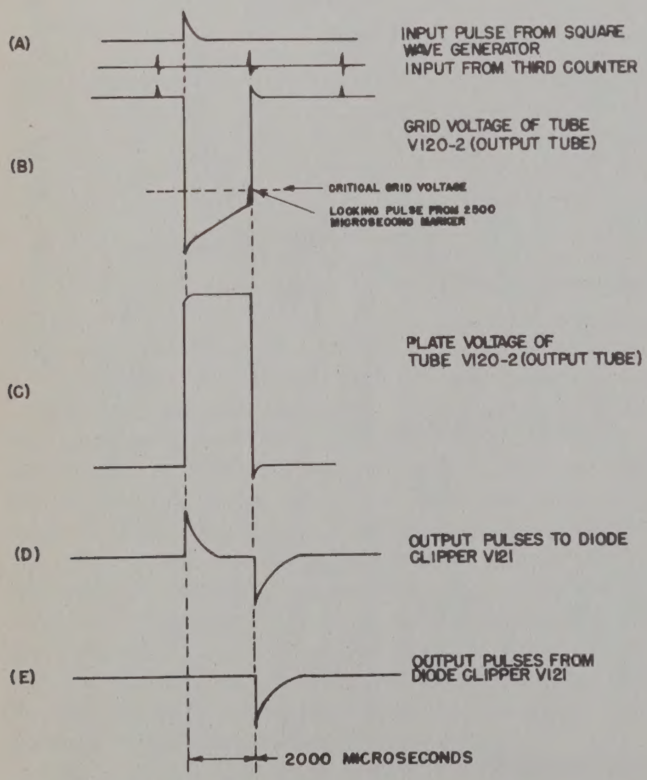

(A)
INPUT PULSE FROM SQUARE WAVE GENERATOR
INPUT FROM THIRD COUNTER
GRID VOLTAGE OF TUBE V120-2 (OUTPUT TUBE)
(B)
CRITICAL GRID VOLTAGE
LOCKING PULSE FROM 2500 MICROSECOND MARKER
PLATE VOLTAGE OF TUBE V120-2 (OUTPUT TUBE)
(C)
(D)
OUTPUT PULSES TO DIODE CLIPPER V121
(E)
OUTPUT PULSES FROM DIODE CLIPPER V121
2000 MICROSECONDS

Figure 4-33—Fixed Delay Waveforms

tubes. The lower cathode potential gives less grid to cathode bias for V120-2, and a shorter delay because the grid reaches conduction sooner. These conditions are demonstrated in Fig. 4-32 which shows the initial negative grid-to-cathode voltage of tube V120-2 for the different time delays, and for each case, the corresponding critical voltages at which the tube starts to conduct.

The voltage at the plate of V120-2 rises sharply as this tube changes from a conducting to a non-conducting condition, and drops sharply when it changes the other way. Therefore the voltage as seen at the plate is a series of positive-going, square-topped pulses. The grid voltage and plate voltage of this tube are shown in curves (B) and (C) of Fig. 4-33.

The square-topped pulses from this multivibrator are passed through the differentiator C176 and R283, and each square pulse is changed into a positive and a negative triangular waveform, as shown in Fig. 4-33D. The leading edge of the square pulse produces the positive pip, and this passes to ground through terminals (5) and (8) of the diode V121. The trailing edge of the square pulse produces the negative pip, and it passes through terminals (4) and (3) of V121 and on to the Pedestal Generator. Since this negative pulse, shown in Fig. 4-33E, trips the Pedestal circuit, the time delay between the start of the A trace and the beginning of the A pedestal will be the time between the start of a positive-going square wave from the Eccles-Jordan Generator, and this pulse. This is the time during which tube V120-2 is cut off.

As explained above, the setting of R202 determines the amount of negative voltage placed on the grid of V102-2 and this voltage in conjunction with the time constant composed of R207 and C173 therefore determines the delay period. Exactely the same delay is always desired, however, and to insure that this delay will remain constant the end of the delay period is synchronized, or "locked," with a 2500 microsecond marker. This locking is accomplished by superimposing the positive-going voltage of the Third Counter, a 2500 microsecond pulse, on the grid of tube V120-2.

The pulse from the Third Counter is coupled to the plate of a gate tube (V116-2, Fig. 4-31) by R208 and C174. The negative portions of the pulse will not go through the tube, and are passed to ground through R259. The positive portions of the pulse go through the tube V116-2 and are conducted to the grid of V120-2.

The positive pulse, applied to the grid of V120-2, has very little effect when the tube is conducting, because the grid is already positive and just draws more current. When the tube is cut off, however, and the grid voltage is just below the critical value, this pulse is enough to start the tube conducting and trip the circuit. This action is shown in Fig. 4-33B where the locking pulse carries the grid above the critical voltage.

The Time Corrector trips the Eccles-Jordan Generator and starts each trace at a time corresponding to the first 500 microsecond marker pulse following a Fourth Counter pulse. One 2500 microsecond, Third Counter pulse occurs a few microseconds before the Fourth Counter pulse, and the next 2500 microsecond pulse occurs exactly 2000 microseconds after the start of the trace. Because the end of the A delay period, or the start of the A pedestal, is locked with this pulse it also occurs exactly 2000 microseconds after the start of the A trace.

If there were no Time Corrector circuit to take up the Second Counter output interval which varies between 150 and 500 microseconds, the delay circuit would have to provide delays varying between 2150 and 2500 microseconds. This would require a special setting of R202 for each position of the STATION (Feed-Back) switch, to insure a grid voltage near enough to the critical value so that the circuit would be tripped by the first 2500 microsecond pulse after the start of the sweep. However, because of the Time Corrector circuit, the delay between the Eccles-Jordan differentiated output pulse and the next 2500 microsecond marker is always 2000 microseconds, and no such difficulties are encountered.

n. LEFT-RIGHT CIRCUIT.—The connections from the plate of V120-1 to terminal one, and from the plate of V120-2 to terminal three of the LEFT-RIGHT switch S101B, make it possible to feed-back positive or negative blocks of voltage to the First Counter storage capacitor. These voltage blocks occur only during the first 2500 microseconds of each sweep, and can be fed into the storage capacitor only when the SWEEP SPEED switch S103-E is on position one.

The effect of the voltages on the First Counter is to slowly charge or discharge the storage capacitor C116, through the resistor R279 (Fig. 4-8). This continuous charging or discharging of the capacitor will cause the steps of voltage (shown in Fig. 4-9C) to assume either an upward or downward slope. Each step will therefore end at a higher, or lower, potential than it started. When the positive voltage block is fed-back, the upward slope of each step will raise the grid of the First Counter tube to firing potential in fewer steps (four instead of five). Conversely, when the negative blocks are fed-back and each step slopes downward, more steps (six instead of five) are required to fire the tube. This represents a change in frequency of the counter chain and hence the sweep rate.

This change in the sweep rate causes the received pulses on the traces to rapidly drift in one direction or the other, when the LEFT-RIGHT switch is manipulated. The operator may therefore move the pulses along the traces rapidly on No. 1 SWEEP SPEED, and by means of the same switch move them slowly on other sweep speeds. (The slow action is due to a small change in the Oscillator frequency, as described under the Crystal Oscillator.)

Should the two halves of the Fixed Delay Multivibrator tube (V120-1 and 2) become unbalanced at any time, the positive and negative blocks of voltage fed-back to the First Counter will be unequal. These will impart unequal upward and downward slopes to the storage capacitor voltage steps which, in one case, will fail to make the counter miscount, while in the other will make it count three or seven. The same effect is obtained if the counter tube grid-to-cathode bias is not set in the center of the stable range. In this case the slopes of the steps are equal, but in one direction or the other this slope is insufficient to cause a miscount. Evidence of these conditions is that the pulses on the traces will move rapidly in one direction when the LEFT-RIGHT switch is turned to one side, but will remain nearly stationary when the switch is turned to the other side.

o. COARSE DELAY MULTIVIBRATOR.—The time delay between the beginning of the lower trace and its pedestal is determined by the delay action of two multivibrator circuits, the Coarse Delay and the Fine Delay, which are connected in series so as to add one delay period to the other. The Coarse Delay has a variable time delay output of from 2000 to 12,000 microseconds in steps of 500 microseconds each. The Fine Delay has a range of approximately 550 microseconds and can be continuously adjusted for any value of time delay between 150 and 700 microseconds. Adding the two gives a possible B delay of from 2150 to 12,700 microseconds.

The Coarse Delay circuit is shown in Fig. 4-34. It is essentially the same as the Fixed Delay, and its principle of operation is very similar. V119-1 is normally biased to cut-off with tube V119-2 conducting. The output from the plate of the first section of tube V111 of the Square-Wave Generator is passed through the isolating resistor, R194, and differentiated by C165 and R193, producing pulses similar to those supplied to the Fixed Delay circuit from the second section of tube V111. The square wave voltage at the plate of the first section of the Eccles-Jordan generator, used in tripping the Coarse Delay circuit is exactly 180 degrees out of phase with the square wave from the second section of the tube, which trips the Fixed Delay circuit. The beginning of the A delay interval produced by the Fixed Delay is coincident with the beginning of the A trace, and similarly, the beginning of the coarse B delay will be coincident with the beginning of the B trace.

The time delay of this multivibrator is the period of non-conductivity of tube V119-2, just as the delay obtained from the Fixed Delay circuit was the period of non-conductivity of tube V120-2. The effect on the time delay period of the fixed grid bias of the normally non-conducting tube was discussed under the 2500 Microsecond Fixed Delay Multivibrator. This effect is used to control the coarse delay time, and the potentiometer adjustment (R332) for the grid voltage is brought out to the front panel of the Power Supply as the Coarse Delay knob. In addition, the resistors R333 and R331 are the LO and HI screwdriver adjustments, also brought out to the front panel of the Power Supply, which set the range of R332. R333 adjusts the voltage at the lower end of R332, which is the maximum bias that may be placed on the grid of V119-1, and R331 adjusts the voltage range of R332. Thus the minimum delay and the range of delay for R332 are set by R333 and R331,

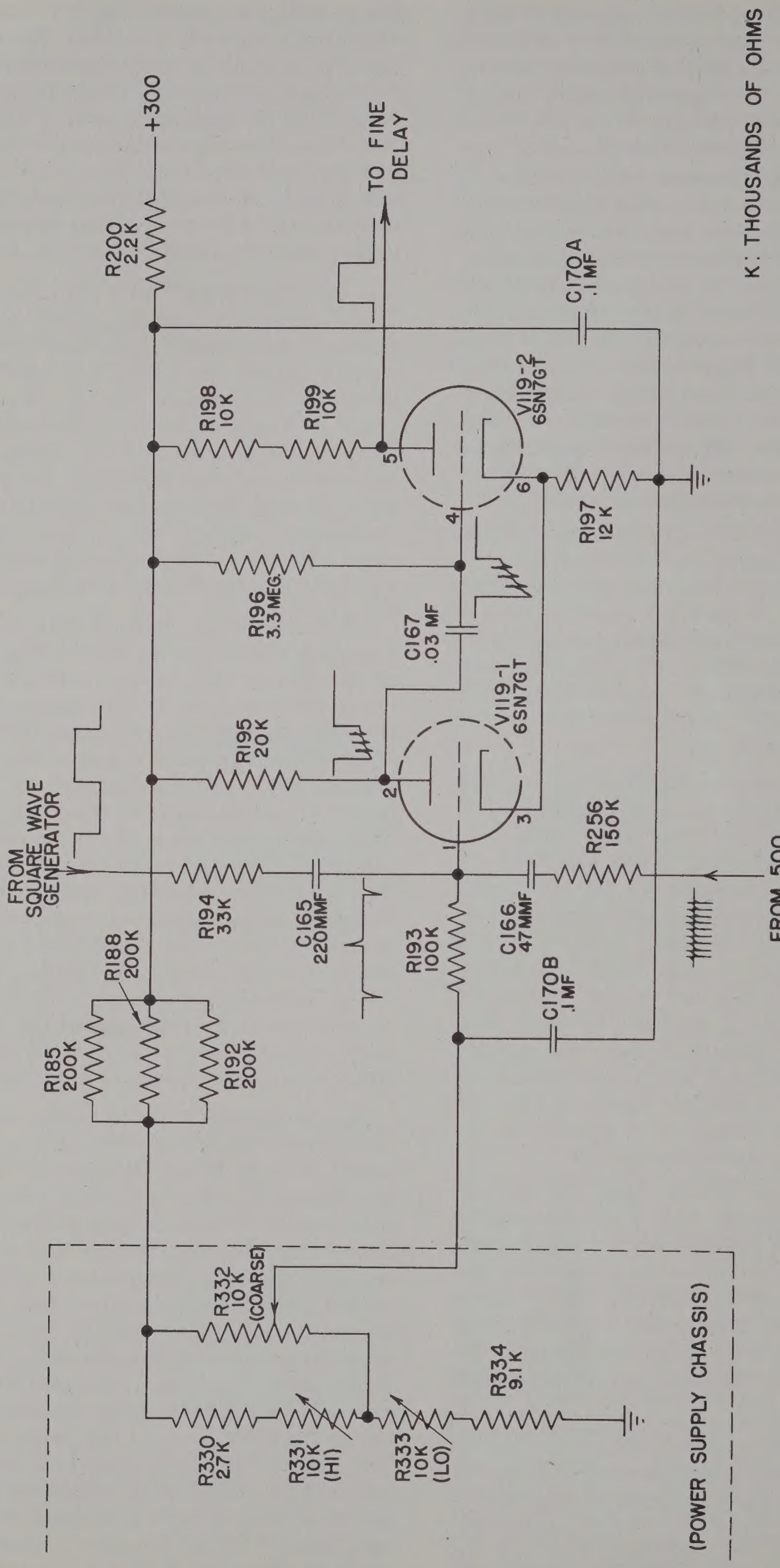

K: THOUSANDS OF OHMS
+300
R200 2.2 K
TO FINE DELAY
C170A .1 MF
R198 10K
R199 10K
V119-2 6SN7GT
5
4
6
R197 12 K
R196 3.3 MEG.
C167 .03 MF
V119-1 6SN7GT
R195 20K
2
3
1
FROM SQUARE WAVE GENERATOR
R194 33K
C165 220MMF
R193 100K
C166 47MMF
R256 150K
FROM 500 MICROSECOND AMPLIFIER
R188 200K
R185 200K
R192 200K
C170B .1 MF
R332 10 K (COARSE)
R330 2.7K
R331 10K (HI)
R333 10K (LO)
R334 9.1 K
(POWER SUPPLY CHASSIS)

Figure 4-34—Course "B" Delay Circuit Diagram

respectively.

The locking pulse for this multivibrator is the amplified 500 microsecond pulse from the Second Counter. These pulses are negative so they are placed on the grid of the normally cut-off tube V119-1. While the tube is cut-off, these negative pulses have no effect, but when the tube is conducting they cause a short duration drop in current, and resulting positive pulses of voltage at the plate. These positive pulses are conducted to the grid of V119-2, and act there just like the positive pulses from the Third Counter when applied to the grid of V120-2 in the Fixed Delay circuit.

The drop in plate voltage of tube V119-1 at the start of the time delay charges the grid of tube V119-2 negatively, and cuts off V119-2. The capacitor C167 must then discharge through the high resistance of R195 plus R196 before the tube will conduct again. The time for this discharge will determine the time delay. The circuit must be capable of a 12,000 microsecond delay, and for this reason C167 is made large so that it requires a relatively long time for its charge to leak off.

The 500 microsecond pulses are passing through C167 during the time it is discharging. These pulses are just momentary peaks in the voltage and do not affect the regular rate at which the initial charge is leaking off the grid, but they do produce positive pips of voltage. By adjusting the discharge rate so that in any 500 microsecond interval the voltage on the grid does not go to a value as high as that produced by the 500 microsecond pulse at the beginning of the interval, one of the pulses will always trip the circuit. This may be more easily understood by reference to Fig. 4-35B. The original drop in plate voltage of V119-1 charges the grid negatively at the start of the delay. This charge leaks off at a regu-

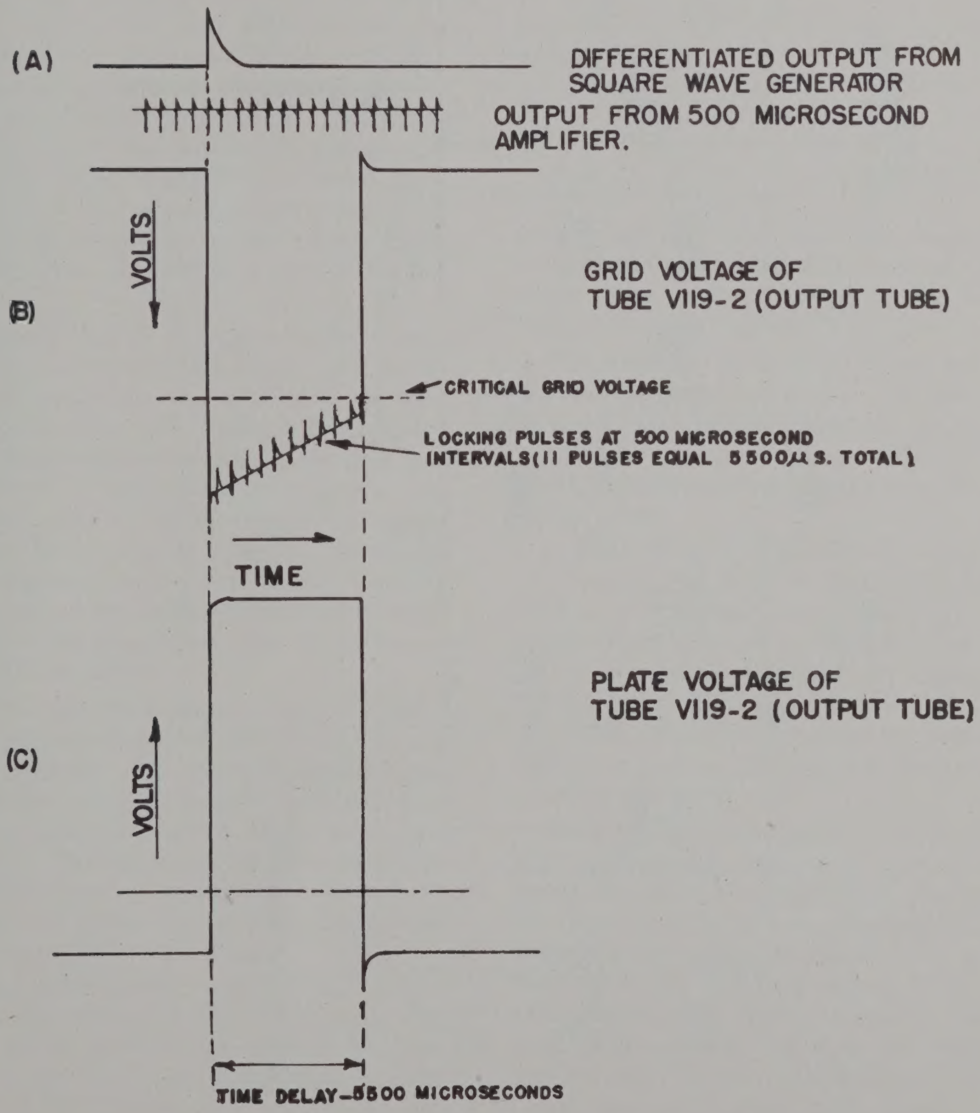
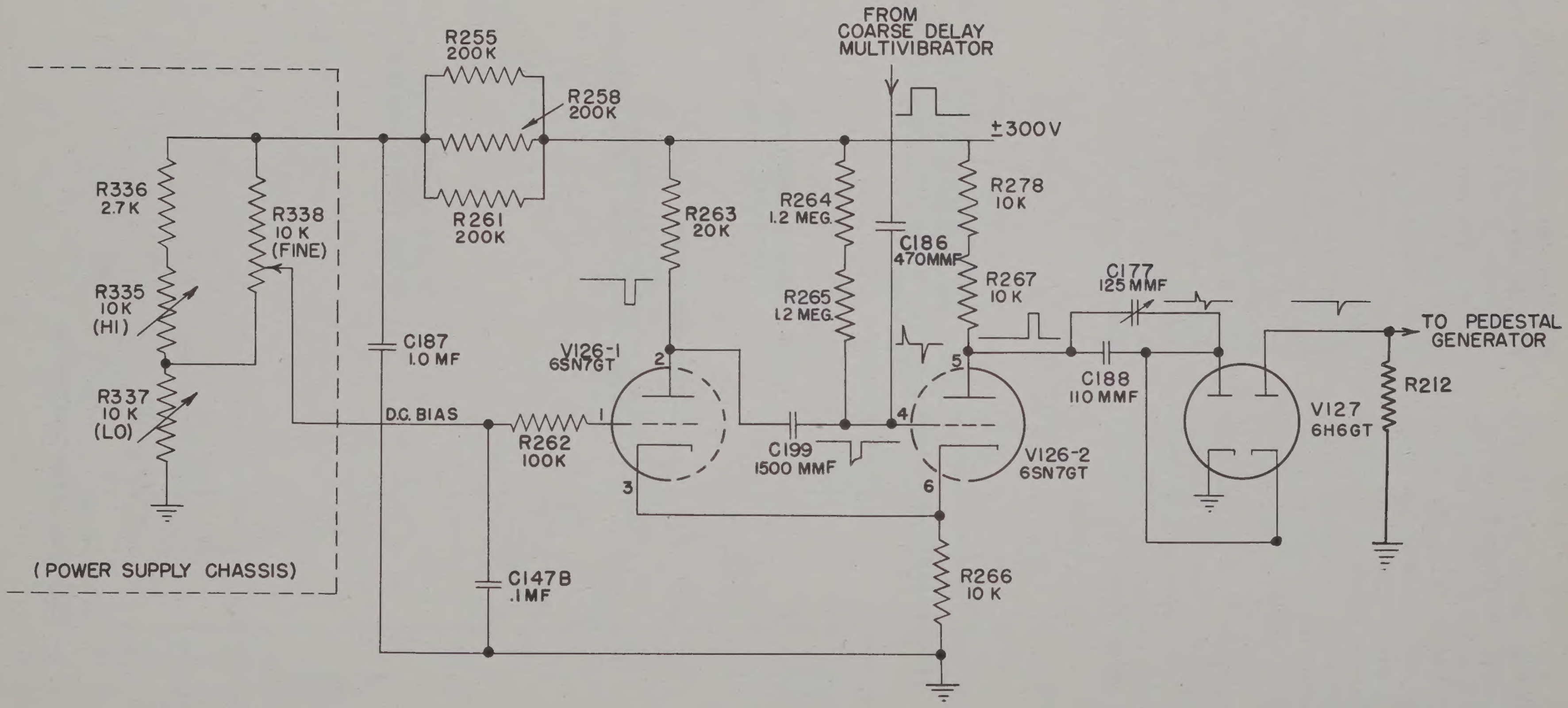

(A)
DIFFERENTIATED OUTPUT FROM SQUARE WAVE GENERATOR
OUTPUT FROM 500 MICROSECOND AMPLIFIER.
(B)
VOLTS
GRID VOLTAGE OF TUBE V119-2 (OUTPUT TUBE)
CRITICAL GRID VOLTAGE
LOCKING PULSES AT 500 MICROSECOND INTERVALS(11 PULSES EQUAL 5500μS. TOTAL)
TIME
(C)
VOLTS
PLATE VOLTAGE OF TUBE V119-2 (OUTPUT TUBE)
TIME DELAY—5500 MICROSECONDS

Figure 4-35—Coarse Delay Waveforms


R255
200K
R258
200K
R261
200K
FROM
COARSE DELAY
MULTIVIBRATOR
±300V
R336
2.7K
R338
10 K
(FINE)
R335
10K
(HI)
R337
10 K
(LO)
(POWER SUPPLY CHASSIS)
C187
1.0 MF
D.C. BIAS
R262
100K
C147B
.1MF
R263
20K
V126-1
6SN7GT
2
1
3
R264
1.2 MEG.
R265
1.2 MEG.
C199
1500 MMF
C186
470MMF
R278
10K
R267
10 K
4
5
6
V126-2
6SN7GT
R266
10 K
C177
125 MMF
C188
110 MMF
V127
6H6GT
R212
TO PEDESTAL
GENERATOR

K: THOUSANDS OF OHMS

Figure 4-36—Fine "B" Delay Circuit Diagram

lar rate, and the pulses are superimposed on it as shown. The top of any one positive pip on the grid, at the start of a 500 microsecond interval, pushes the grid in a positive direction, then returns it to its normal voltage. In the following interval the grid voltage does go in a positive direction, but before it reaches a point as far positive as the previous pip, another pulse is received. In this way the critical voltage can never be passed except by a voltage pip, i.e., at intervals of 500 microseconds each.

The output voltage from the plate of the normally conducting tube V119-2 is shown in Fig. 4-35C. This positive square wave of voltage begins simultaneously with the B trace, and the point where it ends marks the beginning of the Fine Delay period.

p. FINE DELAY MULTIVIBRATOR.—The Fine Delay circuit, Fig. 4-36, is similar to the other multivibrators, differing only in the way in which it is tripped. Tube V126-1 is the normally cut-off tube, and V126-2 is normally conducting. The grid potential of V126-1 is establshed by R335, R337, and R338, which are brought out to the front panel of the Power Supply Unit as the HI and LO screwdriver adjustments and the FINE DELAY control knob, respectively. The action of these controls is exactly the same as the similar controls on the Coarse Delay multivibrator, which have already been explained. The range covered by the delay is much shorter in this case, 150 to 700 microseconds, due to the shorter time constant of C199, R264 and R265.

The positive square wave of voltage from the Coarse Delay is used to trip the circuit. The square wave is differentiated by R263 and C186, and applied to the grid of the normally conducting tube V126-2. The positive pulse from the differentiated wave falls on the grid that is already positive and is dissipated in grid current. The negative pulse at the end of the square wave (i.e., the end of the Coarse Delay period) however, drives the grid of V126-2 negative beyond cut-off. The cathode bias is reduced because of the decrease in current through R266, and V126-1 starts to conduct. This is the beginning of the Fine Delay period.

No locking pulse is used with this multivibrator, therefore tube V126-2 will remain cut-off until enough of the charge on C199 has leaked off to allow the grid voltage to return to conducting range. This makes possible a continuous adjustment, rather than steps, of the delay time over the fixed range. The output of the Fine Delay circuit will be a positive-going square wave of voltage which starts at the end of the Coarse Delay period, and continues for as long as V126-2 is cut-off.

The relationship between the two B Delay circuit output voltages is represented in Fig. 4-37, along with wave shapes at different points in the circuits. The output square wave of the Fine Delay passes through C188 and C177 to the double diode gate tube V127. The capacitors, together with R212, form a differentiator, and the square wave becomes a positive then a negative pulse. The positive pulse passes to ground through the second half of V127, and the negative pulse passes through the other half of the tube to the Pedestal Generator. The resultant waveform and its time relationship is shown in Fig. 4-37D.

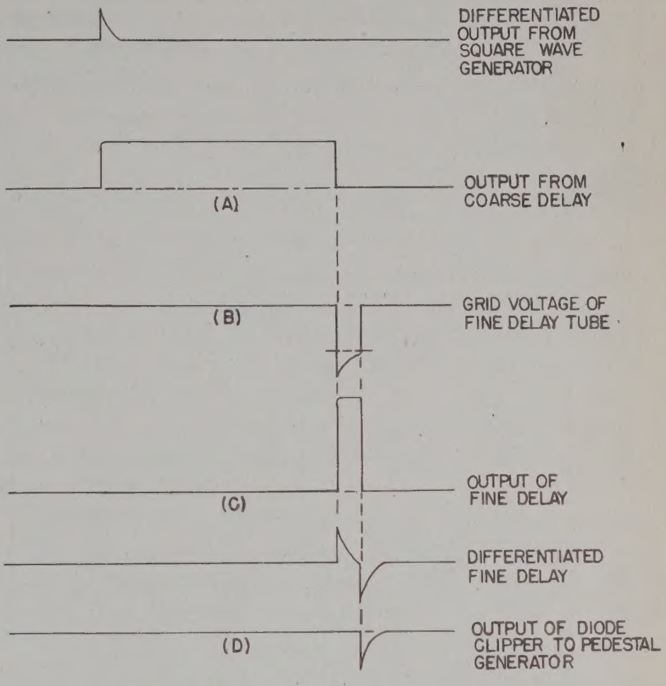

DIFFERENTIATED OUTPUT FROM SQUARE WAVE GENERATOR
OUTPUT FROM COARSE DELAY
(A)
(B)
GRID VOLTAGE OF FINE DELAY TUBE
(C)
OUTPUT OF FINE DELAY
DIFFERENTIATED FINE DELAY
(D)
OUTPUT OF DIODE CLIPPER TO PEDESTAL GENERATOR

Figure 4-37—Coarse and Fine Delay Waveforms

This negative pulse and the negative pulse from the Fixed Delay are both used to trip the Pedestal Generator, and must be approximately the same size in order to make the two pedestals equal. For this reason C177 is made variable, giving control over the size of the B Delay pulse.

q. PEDESTAL GENERATOR.—The Pedestal Generator circuit, Fig. 4-38, is a multivibrator which is very similar to the three delay circuits just described. The negative pulses from the delay circuits trip the generator and it, in turn, produces a square-topped, positive-going voltage wave. This square wave, or block, is placed on the vertical deflection plates of the cathode ray tube and deflects a portion of the trace upward, forming what is called a pedestal.

After the received signals have been located near the leading edges of the pedestals using the slow sweep speed, the pedestals are the only part of the traces that are important. On all other sweep speeds except the first, therefore, the output of the Pedestal Generator is also used to supply blanking voltage. The valleys between the positive-going square blocks are applied to the first grid of the cathode ray tube and blank out the trace, leaving only the top of the pedestal visible in the display.

The differentiated Fixed Delay circuit output is a negative pulse which occurs 2000 microseconds after the start of the A trace. The Coarse Delay, in series with the Fine Delay, produces, after differentiation, a negative pulse

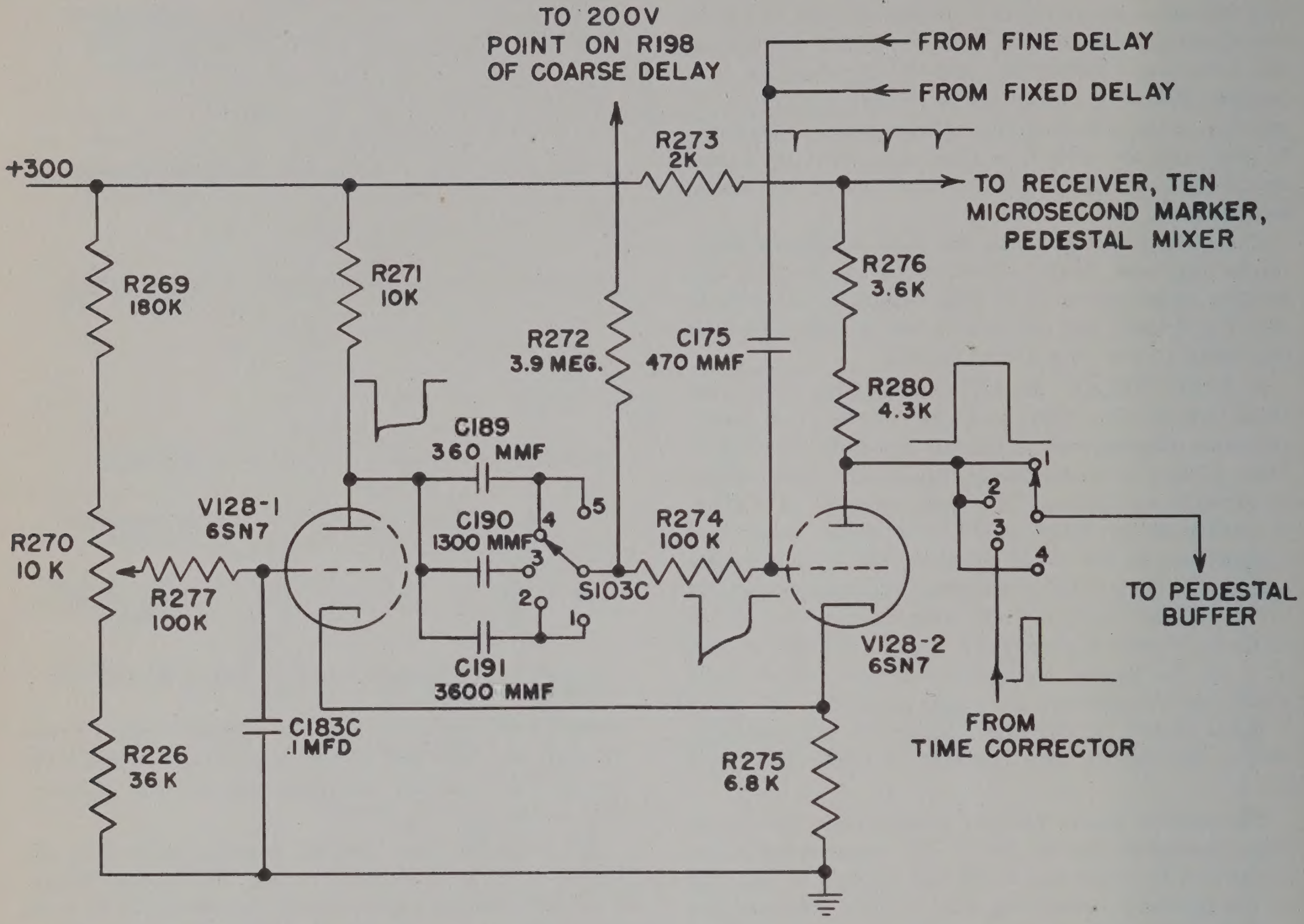

TO 200V
POINT ON R198
OF COARSE DELAY
FROM FINE DELAY
FROM FIXED DELAY
+300
R273
2K
TO RECEIVER, TEN
MICROSECOND MARKER,
PEDESTAL MIXER
R269
180K
R271
10K
R276
3.6K
R272
3.9 MEG.
C175
470 MMF
R280
4.3K
C189
360 MMF
V128-1
6SN7
C190
1300 MMF
R274
100 K
R270
10 K
R277
100K
S103C
TO PEDESTAL
BUFFER
C191
3600 MMF
V128-2
6SN7
C183C
.1 MFD
FROM
TIME CORRECTOR
R226
36 K
R275
6.8 K

Figure 4-38—Pedestal Generator Circuit Diagram

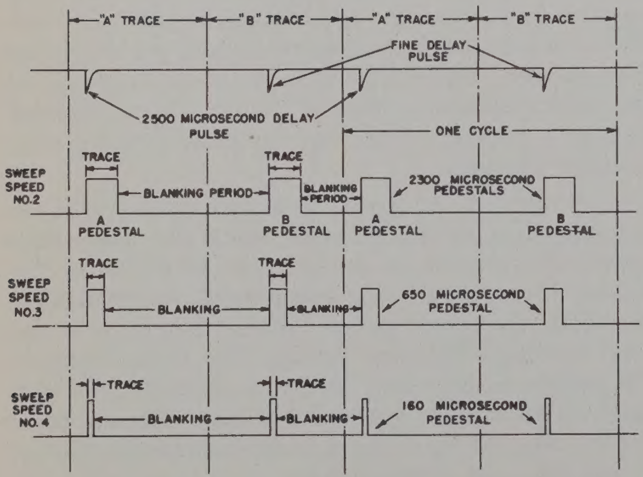

"A" TRACE
"B" TRACE
"A" TRACE
"B" TRACE
FINE DELAY
PULSE
2500 MICROSECOND DELAY
PULSE
ONE CYCLE
SWEEP SPEED NO.2
TRACE
TRACE
BLANKING PERIOD
BLANKING PERIOD
2300 MICROSECOND PEDESTALS
A PEDESTAL
B PEDESTAL
A PEDESTAL
B PEDESTAL
SWEEP SPEED NO.3
TRACE
TRACE
BLANKING
BLANKING
650 MICROSECOND PEDESTAL
SWEEP SPEED NO. 4
TRACE
TRACE
BLANKING
BLANKING
160 MICROSECOND PEDESTAL

Figure 4-39—Pedestal Generator Waveforms

which occurs between 2150 and 12,700 microseconds after the start of the B trace. These output pulses are both connected to the grid of the normally conducting tube V128-2 of the Pedestal Generator. The negative pulse trips the circuit, as described under Delay Multivibrators, and the plate voltage of V128-2 goes sharply positive. This is the start, or leading edge of the pedestal.

The resistor R274 is necessary to keep the grid of V128-2 from swinging too far positive at the end of the delay period and distorting the top of the pedestal. Considering the grid voltage normal when V128-2 is conducting, the grid swings in a negative direction from normal at the beginning of the delay. Part of the negative charge leaks off, and at the end of the delay the positive swing coupled from the plate of V128-1 would carry the grid voltage above normal if it were not for R274. The grid current through the resistor, however, limits the positive swing, and stops it as soon as it gets back up to this normal value.

The length of time that V128-2 is cut off, as in similar multivibrator circuits, is the length of time it takes the negative charge to leak off the grid. This delay time is the length, or duration, of the pedestal on the slow sweep, and on the fast sweep the length of the sweep itself.

To obtain a variable fast sweep period, switch S103C (SWEEP SPEED) selects a different sized coupling capacitor between V128-1 and V128-2 for each switch position. The discharge time of these capacitors, C189, C190 and C191 through the resistor R272 to a 200-volt source (between R198 and R199) varies almost directly with the size of the capacitor selected. On switch positions one and two, with C191 in the circuit, the block length is 2300 microseconds. With C190 in the circuit on switch position three, the block length is 650 microseconds, and with C189 in the circuit on switch positions four and five, the block length is 160 microseconds. This discharge time does not represent a complete discharge of the capacitors, but rather sufficient discharge to bring the grid voltage above the cut-off value, and start V128-2 conducting.

Each of the capacitors, C189, C190 and C191, has its own R-C time constant when in the circuit, but the delay time can be regulated for all three to some extent by R277, which will determine at what grid potential tube V128-2 will start to conduct. This action has been described previously under the Fixed Delay Multivibrator, and the variation in the delay is represented in Fig. 4-32. When the block length has been adjusted in this way with any one of the capacitors in the circuit, the duration times for the other capacitors will be in the proportions of about 2300:650:150.

The pedestal voltages for deflecting the cathode ray tube are taken from the junction of R276 and R273 instead of directly from the plate of the normally conducting tube. This reduces the amplitude to approximately 30 volts, which will produce a pedestal on the trace about one quarter of an inch high.

The voltage for blanking the cathode ray tube is taken directly from the plate of V128-2. When the Receiver Switch S102C is on position one, two or four, the voltage is coupled to the grid of the Pedestal Buffer tube, and the output of the Buffer drives the control grid of the cathode ray tube. When the switch is in position three, the Time Corrector is coupled to the Buffer tube and does the blanking.

The received pulses and output waveforms of the Pedestal Generator are shown in Fig. 4-39. The different pedestal lengths with the different positions of S103C, are all shown on the drawing.

r. RECEIVER SIGNAL, TEN MICROSECOND MARKER, AND PEDESTAL MIXER.—The ten microsecond markers are placed on the top deflection plate of the cathode ray tube, as mentioned previously. In addition, the receiver signals and the pedestal voltages are coupled to this same plate. A suitable means for mix-

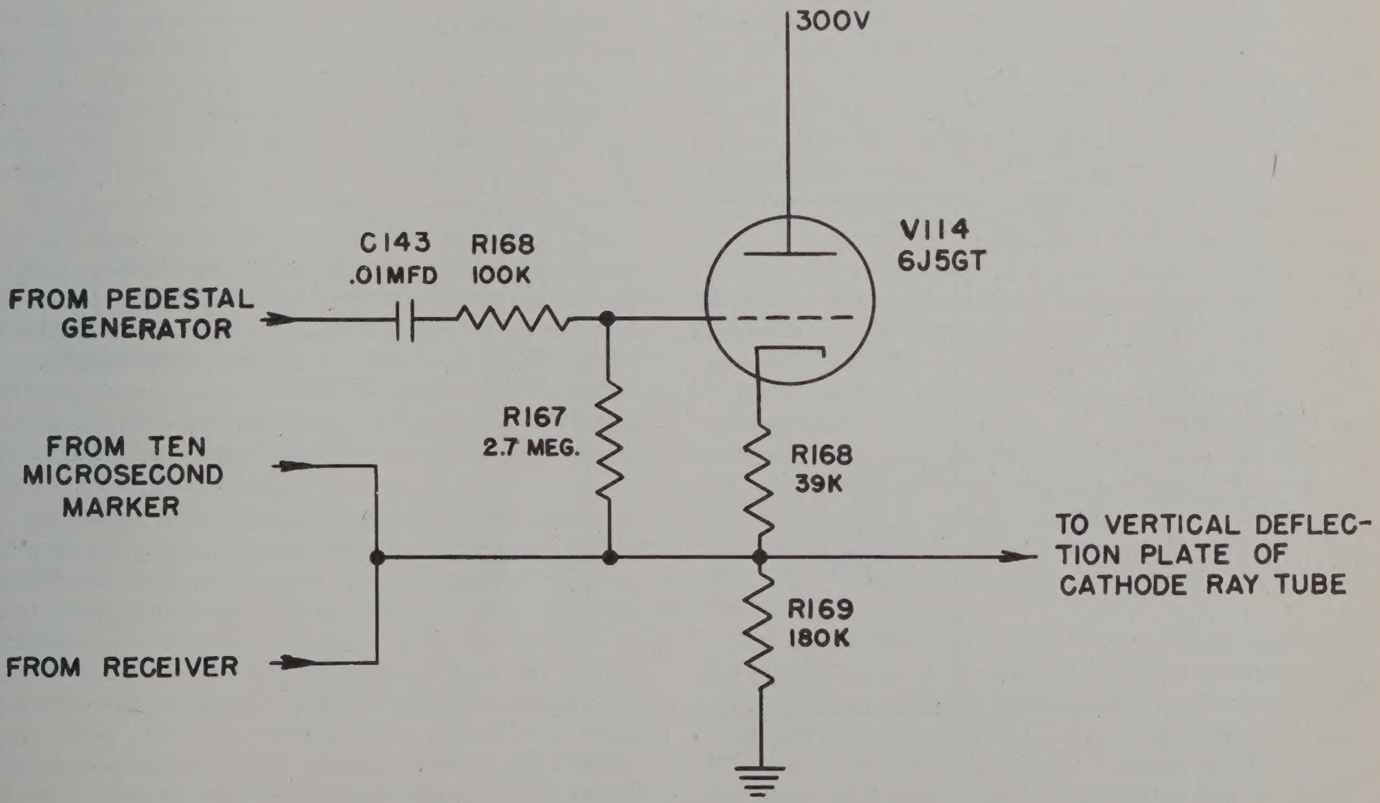


Figure 4-40—Receiver, Pedestal, Ten Microsecond Marker Mixer Circuit Diagram

ing these three voltage functions without interaction is required. The 10 microsecond markers are obtained from a very low impedance source and coupled through a very small capacitor, C114, to the video. Thus the video does not impress a voltage of any magnitude across R105 and L104 in the cathode of V101-2, the Marker tube, and no harmful reaction results between these two.

To mix the pedestals with the 10 microsecond markers and the receiver video signal requires a tube for isolation purposes. For this reason the complete mixing is accomplished in the cathode of tube V114, Fig. 4-40. Not only does this tube serve to isolate, but it also acts as a limiter on the pedestals to make the top flat. This limiting is accomplished in the grid circuit by means of resistor, R166.

The complete mixed wave present in the cathode of V114 is then applied to the upper vertical deflection plate of the cathode ray tube V129 through S102A, the Receiver Switch, and through a d-c isolating condenser C202. This coupling circuit is shown in the diagram of the Oscilloscope, Fig. 4-45.

Also in Fig. 4-45 is shown R162 which is used as an isolating resistor connected to a 150 volt reference voltage for the cathode ray tube vertical plates. In the Model DAS both this resistor and C202 were omitted and the signals were coupled directly to the plate. This resulted in poor focus of V129 because of wide variations in cathode ray tubes, therefore the circuit was changed in the Model DAS-2 to the one shown in Fig. 4-45. Kits of parts for changing the circuit in the Model DAS Units have been made available for installation in the field. The reason for the poor focus will be explained later in the discussion of the Oscilloscope.

s. PEDESTAL BUFFER.—The square waves of voltage used for blanking the fast sweeps are taken directly from the plate of the Pedestal Generator tube V128-2. These waves are positive-going squares of voltage and the time interval between the squares is the desired blanking period. Blanking voltage for the slow sweep, it will be remembered from the discussion of the Time Corrector, is a negative-going square wave from the plate of tube V110-2 (Fig. 4-20) and the time interval contained in the negative squares is the desired blanking period. By making all pedestal blanking waves reference at the top, or the most positive point, the desired blanking period in each case is represented by the negative-going part of the waves.

The Sweep Speed switch S103A selects which blanking voltage shall be placed on the grid of the Pedestal Buffer tube V123-1, Fig. 4-41. In position one, for the slow sweep, it is the Time Corrector voltage which is selected, and for all other sweep speeds it is the Pedestal Generator voltage. The input to the Buffer is high impedance to prevent overloading of the driving circuits.

The Buffer tube, V123-1, is connected as a cathode follower. The cathode of the tube, with no signal on the grid, will be at a relatively high potential because of the cathode and grid resistor connections. As current through

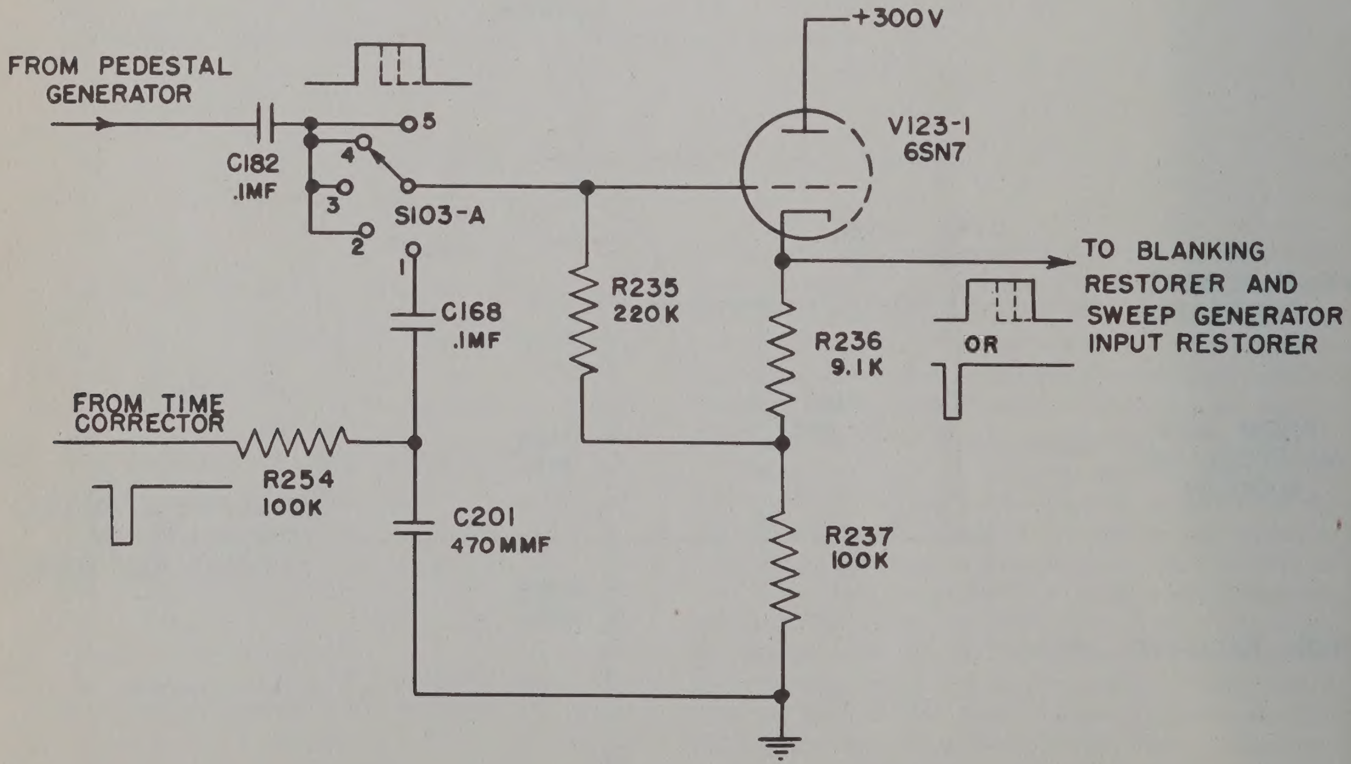


Figure 4-41—Pedestal Buffer Circuit Diagram

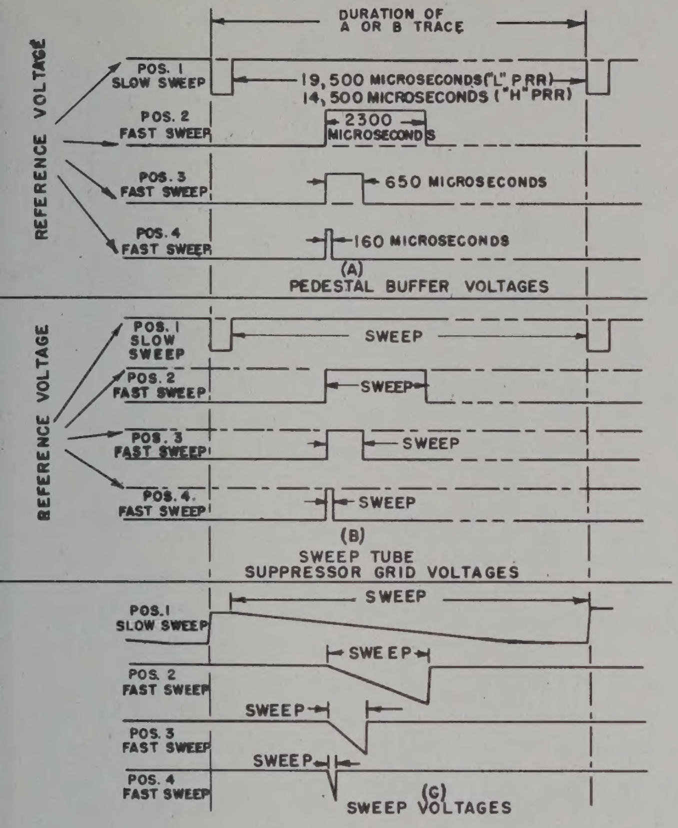


Figure 4-42—Pedestal Buffer Waveforms

the tube causes a voltage drop across the cathode resistors R236 and R237, it carries both the cathode and grid positive. By the time sufficient current is flowing in R236 to establish a limiting bias on the tube (assume 10 volts) the grid is about 100 volts positive, and the cathode 110 volts.

Carrying both the grid and cathode at a positive voltage makes it possible for this tube to follow a large negative signal. The cathode voltage can be reduced only as low as ground potential, limiting the signal voltage it can follow to the normal cathode voltage. If the grid were connected to ground instead of a point on the cathode circuit, a ten volt bias would mean the cathode was at ten volts and could only follow a ten volt negative signal. Assuming the cathode is at 110 volts, it can follow a 110 volt signal.

The output of the Pedestal Buffer is a square wave of voltage, like the input, and only very slightly reduced in amplitude. This square wave is used both for tripping the Sweep Generator circuit and for blanking the cathode ray tube.

t. SWEEP GENERATOR.—The voltage for sweeping the trace across the screen of the cathode ray tube must be a sawtooth wave, starting either at a high voltage and decreasing, or at a low voltage and increasing at a constant rate. The proper timing of the sweep has already been discussed in several places in the text. For the slow trace it is controlled by the Time Corrector, and the sweep period is 19,500 microseconds with PRR at L, and 14,500 microseconds with PRR at H. (See Fig. 4-19.) For the fast traces the timing is done by the Pedestal Generator with the sweep time as shown in Fig. 4-39. The timing circuits actually produce square waves of voltage during the blanking period, and the sweep must occur in the interval between these squares. The Sweep Speed switch selects the proper timing wave and places it on the grid of the Pedestal Buffer tube. The desired blanking voltage for the selected sweep speed is always present, therefore, in the output from the Pedestal Buffer.

There are two other requirements for the sweep besides timing, first that the length of the trace in inches be approximately the same irrespective of the sweep speed, and second that the trace always be centered on the screen and not run off one side or the other. The deflection of the beam in the cathode ray tube is directly proportional to the difference in voltage, or voltage gradient between two parallel deflection plates. Zero gradient is represented by zero deflection when the beam is centered on the screen. Thus we may think of voltage amplitudes and reference points as trace amplitudes and reference points.

Fig. 4-42A shows the output waveforms from the Pedestal Buffer. Although the desired timing for the sweep is contained in each wave, for the slow sweep this period is between negative going square blocks and for the fast sweeps it is the period of the positive-going blocks. Before these waves may be utilized by the Sweep Generator circuit, the d-c reference voltage must have the same position relative to the useful portion of the square wave in each case. This may be done by making the neutral, or reference voltage, occur at the top of the waves, as shown in Fig. 4-42B. This places the sweep period between negative going blocks for all positions of the Sweep Speed switch.

In the Sweep Generator circuit, Fig. 4-43, the tube V123-2 achieves this reference of the timing waves. During the application of a positive going voltage to V123-2 it passes current and discharges the right-hand side of the capacitor C181, keeping it at ground potential. When the positive going wave is complete the capacitor assumes a negative charge approximately equal to the positive wave (about 100 volts). This negative charge cannot leak off through V123-2 as the tube is non-conducting and will remain on C181 without much loss for 1/25 of a second. The voltage in the section of the circuit connected to the suppressor grid of tube V124 therefore becomes the desired wave shown in Fig. 4-42B.

The Sweep Generator tube V124 normally conducts during the trace. The screen grid is connected to the supply voltage through the bleeder resistor R239 and is by-passed to ground by C183A. The cathode is tied to ground and the control grid is connected through a resistance, R242, to a positive voltage and to the plate through C194. R240 is the plate load, and when the suppressor grid is at ground (zero signal) the drop

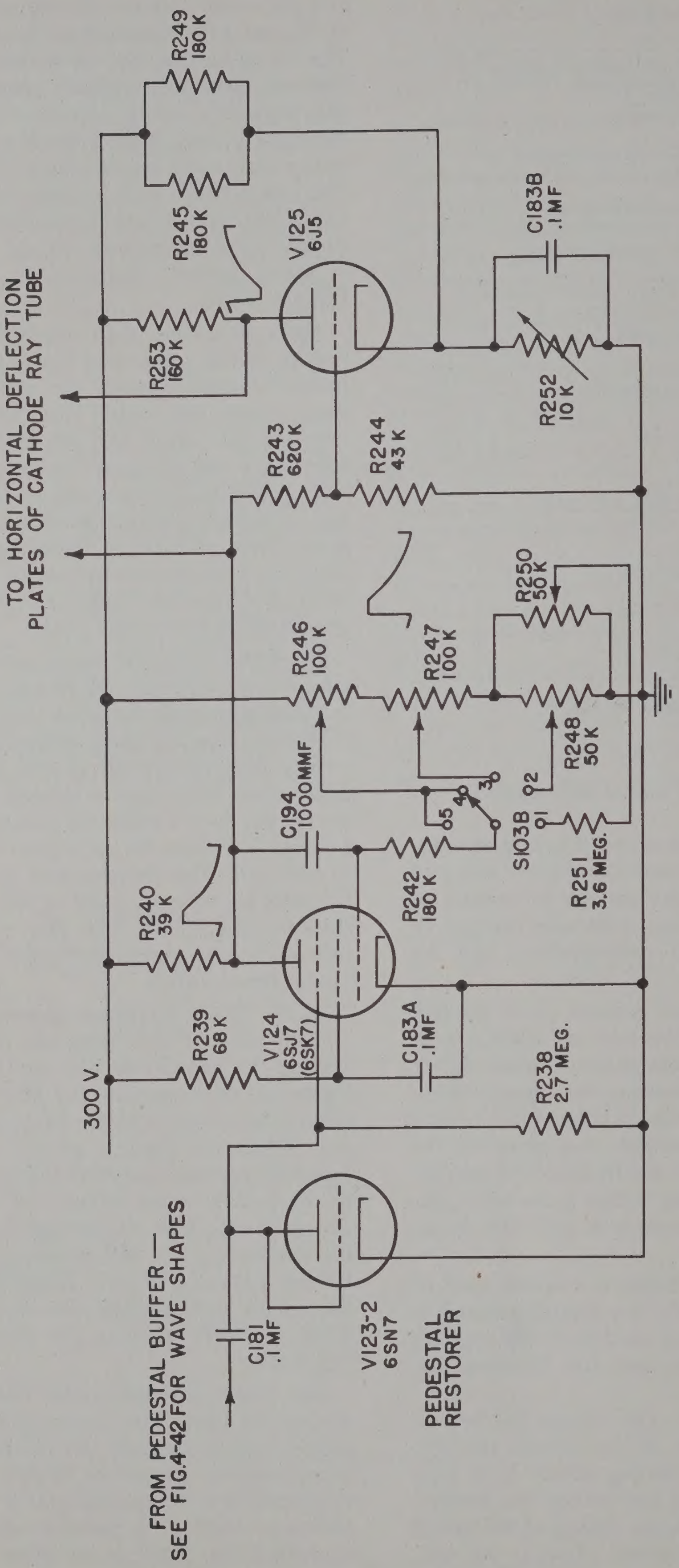

TO HORIZONTAL DEFLECTION PLATES OF CATHODE RAY TUBE
R249 180 K
R245 180 K
V125 6J5
C183B .1 MF
R253 160 K
R252 10 K
R243 620 K
R244 43 K
R250 50 K
R246 100 K
R247 100 K
R248 50 K
C194 1000 MMF
S103B
1
2
3
4
5
R251 3.6 MEG.
R240 39 K
R242 180 K
R239 68 K
V124 6SJ7 (6SK7)
C183A .1 MF
300 V.
R238 2.7 MEG.
FROM PEDESTAL BUFFER — SEE FIG.4-42 FOR WAVE SHAPES
C181 .1 MF
V123-2 6SN7
PEDESTAL RESTORER

Figure 4-43—Sweep Generator and Amplifier Circuit Diagram

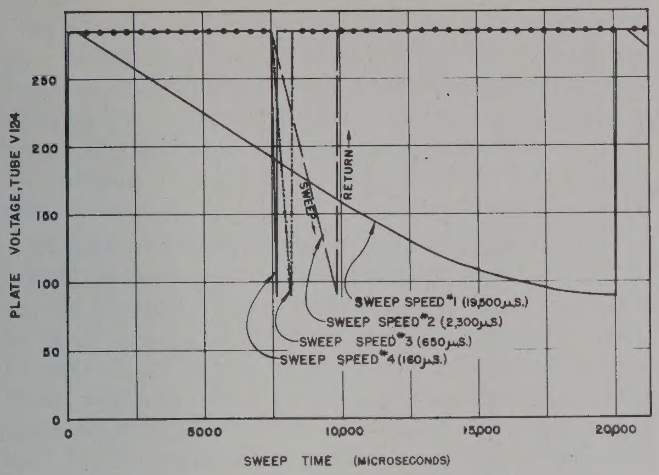


Figure 4-44—Sweep Generator Waveforms

across this load would eventually reduce the plate voltage to approximately 20 volts if C194 were completely discharged.

The negative going square waves, Fig. 4-42B, when received by the suppressor grid, are sufficient to stop the flow of plate current in the tube, and allow the plate to rise to the supply voltage. The sudden (about 50 microseconds) rise in plate voltage is coupled back to the control grid through C194, but it has no appreciable effect on grid potential because the grid is already positive and drawing current. The grid merely draws more current, effectively passing the signal to ground. As long as the suppressor grid is negative the plate voltage remains practically constant at supply voltage.

When the negative going voltage is removed from the suppressor grid the tube begins to conduct current. This current lowers the plate voltage of the tube, and a negative going voltage passes through C194 to the control grid. The grid swings negative and limits plate current to just a little more than it was when the suppressor grid was negative. This negative charge on the control grid slowly leaks off through the grid leak resistance, R242 and other resistors selected by S103B, and as it does so, the plate current increases.

The rate at which the grid voltage rises depends upon the size of the capacitor C194, the amount of resistance in series with the grid, and the potential to which it is connected. The capacitor is a fixed value, and the grid resistance and voltage source are selected by switch S103B. This switch is the SWEEP SPEED control which is brought out to the front panel.

For the slow sweep, where a very slow rate of increase of grid voltage is desired, switch S103B makes contact with position one. This adds grid resistor R251, in series with R242, which is always in the circuit, and makes contact to R250. In the other switch positions, R251 is omitted and contact is made to R246, R247, or R248. The higher the voltage at the point on these resistors to which contact is made, the faster the grid will swing in a positive direction. Each tap on the resistors is a screwdriver adjustment, therefore switch S103B selects the voltage range and the screwdriver adjustments very accurately fix the exact voltages and resultant discharge rates.

Fig. 4-44 shows one cycle of the plate voltage output from tube V124 for each sweep speed. Notice that at the trailing edge of each sweep the minimum voltage is about 90 volts. By not allowing a complete discharge of C194 before the next positive swing, small changes in rate of discharge cause corresponding changes in the voltage at this minimum point. This gives control by means of the potentiometers R246, R247, R248, and R250, of the minimum voltage point, or the maximum amplitude of the sweep.

The output from the Sweep Generator, as shown in Fig. 4-44, is a sawtooth wave, included between 90 and 285 volts. This may be considered as an alternating voltage of 195 volts peak-to-peak, superimposed upon a fixed d-c or reference voltage.

u. SWEEP AMPLIFIER.—The plate of V124 is directly connected to one end of the voltage divider consisting of R243 and R244 (Fig. 4-43) the grid of the amplifier tube V125 is connected to the junction point of R243 and R244 and the other end of the divider is tied to ground. The amplification factor for V125 with a plate load resistance of 160,000 ohms is about fifteen, and the reduction ratio of the voltage divider is about fifteen to one. This makes the amplitude of the output wave of the amplifier approximately equal to the amplitude of the output wave of the Generator, but the phase is displaced 180 degrees.

The plate of V124 is connected to one horizontal deflection plate of the cathode ray tube, and the plate of V125 is connected to the other. The position of the trace will be determined by the difference in voltage between these two at any instant, and if the trace is to be centered on the screen, the difference at the positive maximum must be equal to the difference at a negative maximum. In other words, the trace must be made to start as far to one side of the middle of the screen as it will end at the other side. This must hold true for all sweep speeds.

To accomplish this the voltage divider, R243, R244 establishes an average d-c grid potential on V125 of about 11V. above ground. The cathode potential is then built up to about 20V. above ground by means of the tube current through R252 and by means of the voltage divider R245, R249, R252. Under these conditions the d-c plate voltage of V125 is approximately equal to that of V124. If the peak-to-peak voltages of the sweep waveforms at the plates of V124 and V125 are the same but 180° out of phase with each other, the trace will be centered (the difference of potential between the horizontal deflection plates of the cathode ray tube will go equally far on either side of zero).

R252, by means of its control over grid-to-cathode bias of V125 (the d-c grid potential being fixed) can be

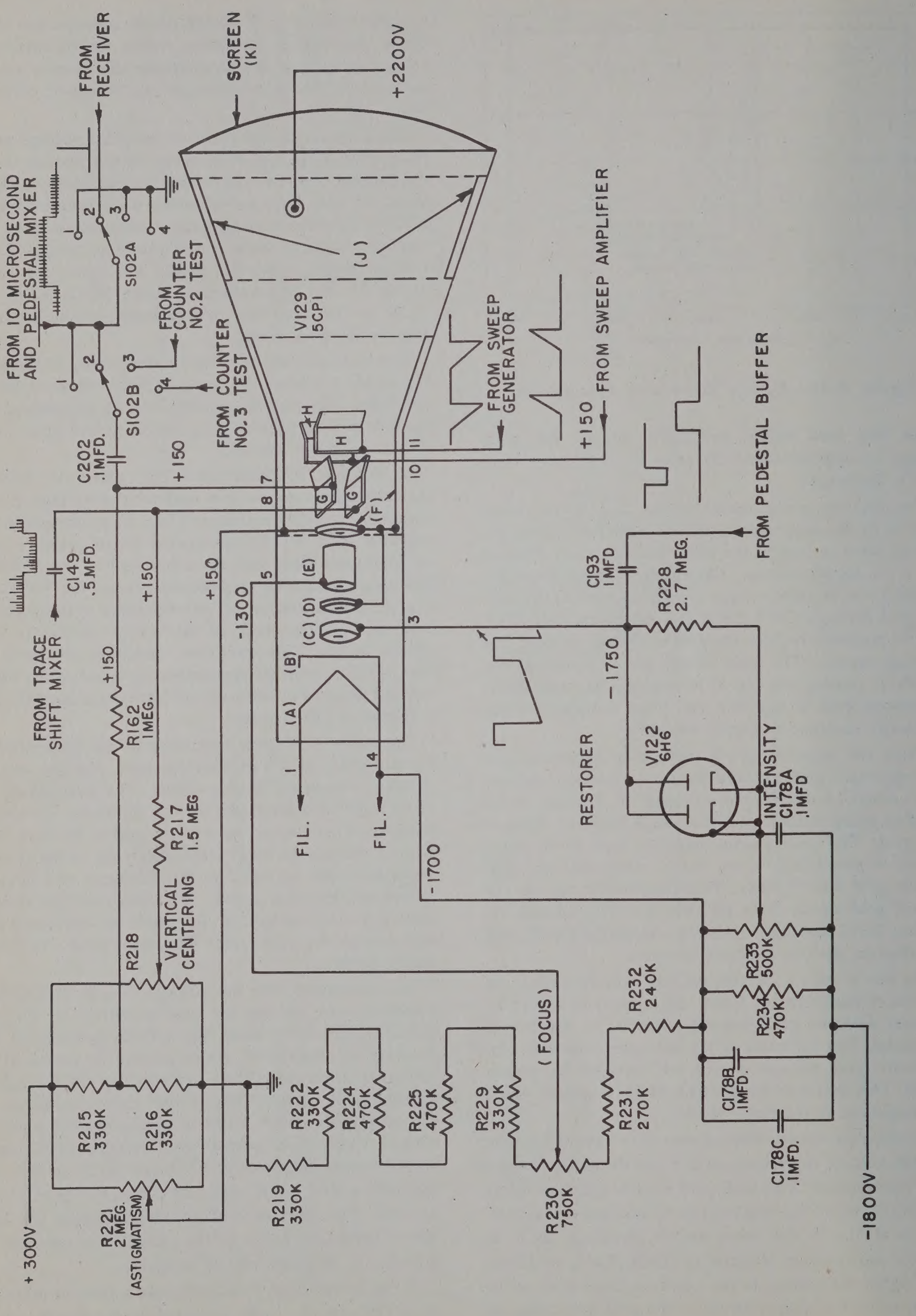

FROM RECEIVER
SCREEN (K)
+2200V
FROM 10 MICROSECOND AND PEDESTAL MIXER
S102A
FROM COUNTER NO.2 TEST
FROM COUNTER NO.3 TEST
S102B
C202 .1MFD.
+150
V129 5CP1
(J)
H
G
(F)
(E)
(D)
(C)
(B)
(A)
FROM SWEEP GENERATOR
FROM SWEEP AMPLIFIER
+150
FROM PEDESTAL BUFFER
FROM TRACE SHIFT MIXER
C149 .5 MFD.
+150
R162 1MEG.
R217 1.5 MEG
+150
-1300
C193 1MFD
R228 2.7 MEG.
-1750
RESTORER
V122 6H6
INTENSITY C178A .1MFD
FIL.
FIL.
-1700
R218
VERTICAL CENTERING
R233 500K
R234 470K
R232 240K
(FOCUS)
C178B .1MFD.
C178C .1MFD.
R215 330K
R216 330K
R222 330K
R224 470K
R225 470K
R229 330K
R231 270K
R219 330K
R230 750K
R221 2 MEG. (ASTIGMATISM)
+300V
-1800V
1
2
3
4
5
7
8
10
11
14

Figure 4-45—Oscilloscope Circuit Diagram

used as a horizontal centering control since variations in grid to cathode potential will vary the tube current and hence the d-c potential at the plate. The bleeder current through R245 and R249 gives this control its required range, and also reduces the degenerative effect of R252 on the gain of V125 by making possible the use of a smaller resistor.

Because of the rapid sweep and the sensitivity of the Sweep Generator circuit, any irregular variations in the current through V124 will displace the trace, causing it to be irregular and blurr, or jitter. One common cause of irregularity in the output is the type of tube used. Some makes of 6SK7 (including a number of Kenrad tubes manufactured at one time) have a straight heater wire in the cathode and with this type of construction an uncancelled electromagnetic field is built up around the cathode. This field is constantly being reversed by the alternating current in the filament, and causes small variations of tube current at heater supply frequency. These tubes should be avoided. Other makes of 6SK7 tubes, such as the RCA, use a double helix wound filament, a filament which is coiled back upon itself in such a way that the field from one half cancels the field from the other half. These tubes are very satisfactory, and will be found in all models of the DAS.*

Interchangeable with the 6SK7 tube for this application, is the 6SJ7 of which all makes will prove satisfactory. If the proper 6SK7 tube is not available for a Model DAS, a 6SJ7 should be substituted. Models DAS-2 are equipped with the latter tubes when they leave the factory.

v. OSCILLOSCOPE.—The Oscilloscope, Fig. 4-45, is the final stage in the Indicator Unit. This stage contains a cathode ray tube, and the controls which regulate and direct the electron beam inside of it. The controls, in turn, are driven by the voltage waves from the previous stages of the unit.

The cathode ray tube, V129, is a 5CP1, having a five inch diameter fluorescent screen with a medium persistence time. The medium persistence means that a spot on the screen will continue to glow with ten per cent brilliance after about 0.015 second, and one per cent after 0.051 second from the time the beam is moved away.

The elements of the tube are as shown in Fig. 4-45, from left to rght: (A) heater; (B) cathode; (C) control grid (grid No. 1); (D) screen grid (grid No. 2); (E) focusing anode (anode No. 1); (F) accelerating anode and bulb-coating (anode No. 2); (G) vertical deflection plates (DJ3 and DJ4); (H) horizontal deflection plates (DJ1 and DJ2); (J) supplementary accelerating anode bulb-coating (anode No. 3); (K) projection screen.

Each of the elements (C) (D) (E) (F) in the neck of the tube, is in the form of a cylindrical box with a small round aperture in the center of the ends for passing a thin stream of electrons. This stream, or beam as it is commonly called, is accelerated to a high velocity by the field between (B) and (E), bent by the field from the deflection plates, accelerated further by the field from the anode coatings, and then strikes the screen, causing fluorescence.

To best understand the oscilloscope, first consider its operation when no signal or external excitation is being received. Although the conventional concept of current is a flow from a high to a low potential, the negatively charged electrons actually flow from a lower to a higher potential. In this discussion the true electron flow will be described, and not the conventional current.

The indirectly heated cathode (B) at the base of the tube, emits electrons in all directions. The control grid (C) is connected through R288 and V122 to the potentiometer R233. This potentiometer is between the cathode of V129 and the negative high voltage source and holds the grid at a potential lower than that of the cathode. The grid will tend to repel the electrons, therefore, and limit the number which will pass through its small aperture to form the beam. If no current flows through the opening in the grid because of its high negative bias, the tube is said to be "blanked", and no spot appears on the screen.

The variable tap on the potentiometer R233 will fix the amount of the bias between the grid and cathode and thus control the density of the beam. Variation of the density of the beam varies the intensity of the fluorescence at the screen, thus the potentiometer shaft is brought out to the front panel as the screwdriver adjusted INTENSITY Control.

The Restorer tube, V122, is a gate in the control grid circuit which will pass electrons to the grid but not away from it. Whenever the grid tends to become more positive than the tap on R233, current flows through V122 removing the charge and equalizing the potential of the two points. Whenever the grid is made more negative, however, the electrons cannot flow back through V122 but must leak off very slowly through the high resistance of R228.

The screen grid (D) is the next element in the electron gun and is connected to the first accelerating anode (anode No. 2). The screen is therefore at a positive potential and gives an acceleration to the electrons. The most important function of this grid is to shield the control grid from the focusing anode and prevent any interelectrode interaction. If it were not for this shielding effect, changing the focus would tend to change the intensity, and changing the intensity would spoil the focus. Many of the first equipments were shipped wth Dumont tubes which do not have this screen grid. To obtain the clearest focus with these tubes it is necessary to have the voltage on all elements exactly at optimum values.

The focusing anode (anode No. 1), (E), is at a negative potential with respect to ground, although at a higher potential than the grid. The electrons which enter the anode near its axis are repelled equally in every direction, perpendicular to their line of motion, by the negative potential on the wall of the anode. This forces the electrons into a very thin stream along the axis with a thickness dependent upon the setting of R230, the FOCUS control.

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*All makes of 6SK7 tubes are satisfactory in other circuits where they are required.

The last element of the electron gun is the accelerating anode (F) (anode No. 2), which is connected to the slightly positive voltage of the potentiometer R221. The reason for this adjustment being called the ASTIGMATISM control will be explained later.

The beam from the gun passes between the vertical deflection plates (G) and the horizontal deflection plates (H). One vertical plate is connected to the mid-point of R215 and R216 so that the other plate, connected to the variable tap on R218, may be set at either a higher or a lower potential than the first. In this way the voltage gradient between plates may be adjusted to deflect the negatively-charged beam either up or down. R218 is brought out as the Vertical Centering screwdriver adjustment on a bracket on the left side of the Indicator chassis.

Note

> This adjustment is on the front panel of the Model DAS Indicator before it is modified to include the PRR switch.

The controls for the horizontal deflection plates are integral parts of the Sweep Generator and Amplifier. The method for fixing the gradient between the plates was discussed in conjunction with those circuits. One feature of all of the plates, taking the four as a group, should be mentioned. The surrounding field must be at the mean potential of the group, or they will distort the beam. In addition, still less distortion will result if the mean potential of each pair is the same, and for this reason it is advisable to have both sets of plates operating in the same voltage range.

To achieve the desired surrounding field for the plates, the throat of the tube is coated with aquadag, a conducting material composed mostly of carbon. This coating (F) is connected to the first accelerating anode (Anode No. 2) and then to the ASTIGMATISM control, R211. By adjusting the control, the field around the coating may be made to conform with the desired mean potential of the deflection plates and reduce the distortion of the beam (i.e., the astigmatism), as the beam passes the plates. Poor adjustment of the control results in a flattening of the spot in either a horizontal or vertical direction.

The beam, after leaving the deflection plates, is given a final acceleration by the field from the supplementary accelerating anode coating (J) (Anode No. 3). This anode coating is also of aquadag and appears in a band which runs up the bulb nearly to the screen. It is connected through the side of the bulb to the positive side of the 2000 volt power supply.

It should be noted that the total voltage across the tube from cathode to screen is approximately 3800 volts. The deflection plates are operated close to ground potential, being only 300 volts positive at the most.

When no signal is applied to the plates of the tube and they are adjusted to equal potentials, the electron beam will strike the center of the screen. As soon as the sweep voltage is applied, the beam will rapidly move to the left edge of the screen, sweep slowly across to the right edge, and then return, rapidly, to the left edge where it will stop before sweeping across again.

The sweep occurs in the period during the positive-going squares of voltage from the Pedestal Buffer. The blanking waveform on the grid of the cathode ray tube acts so as to turn off the electron beam at all times except during a sweep. The output waves of the Pedestal Buffer are shown in Fig. 4-42A. These waves must be made to reference at the top of the squares, as shown in Fig. 4-42B, before they can be used. They are coupled to the control grid of the cathode ray tube by C193, and V122 achieves the referencing by restorer action, just like V123-2 did for the Sweep Generator. When a positive-going, leading edge of a square is received by the grid circuit of the cathode ray tube, current flows through the Restorer tube V122 and holds the grid at a constant voltage. At this potential the cathode ray tube conducts, and also in this period (a positive-going square of voltage from the Pedestal Buffer) the sweep is occurring. When the negative-going, trailing edge of the square is received, the current cannot flow back through V122 and the grid is driven sharply negative, cutting off the beam and "blanking" the tube. The negative charge leaks off through R228 so slowly that the tube will remain "blanked" until the next positive-going voltage is received. Thus the return sweep of the beam and the stationary spot between sweeps are removed from the screen.

The output from the Trace Shift Mixer, shown in Fig. 4-27, is coupled to the bottom deflection plate. The positive-going markers on this wave will attract the electron beam and deflect it in a downward direction. This means that the wave as pictured in Fig. 4-27 will be inverted on the screen.

The RECEIVER Switch, S102B, is coupled to the upper deflection plate by C202. In normal operation this switch makes contact with positions one or two, and receives the 10 microsecond markers and the pedestal voltage waves. These are positive-going voltages, and on the top deflection plate will deflect the beam upward.

All of the above elements—sweep, blanking, time markers, trace separation, and pedestals—go together to make up the complete trace. The Block Diagram of the Indicator Unit, Fig. 7-20, shows how one circuit feeds into another until eventually all terminate in the Oscilloscope. The time relationship of the output waves of the circuits are shown in Fig. 7-19. It is necessary in some cases to show the wave for both slow sweep and fast sweep because of large differences in the position and wave shape due to the different circuits used for timing the different sweeps.

The slow sweep (No. 1 SWEEP SPEED) oscilloscope pattern is shown in Fig. 4-46. This includes all of the markers and the pedestals. The fast sweep (No. 3

SWEEP SPEED) pattern, Fig. 4-47, includes just the first 650 microseconds of the pedestals, and shows clearly the ten and 50 microsecond markers, plus two 500 and one 2500 microsecond marker on the B trace.

The only remaining item to be included on the trace is the signal from the receiver. Positions one and two of S102B (Fig. 4-45) are also connected to S102A. These two switches are ganged together and controlled by the RECEIVER knob on the front panel. S102A connects S102B with the receiver when in position two, i.e. RECEIVER ON. In all other positions S102A is grounded so that no signal from the Receiver can get into the deflection plate circuit.

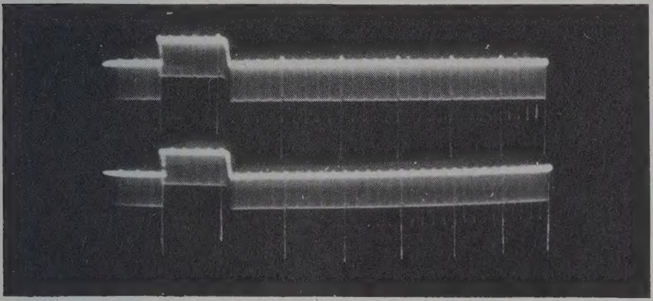


Figure 4-46—Oscillogram, Sweep Speed No. 1

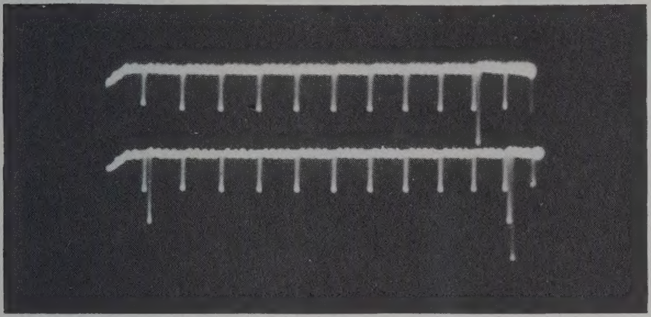


Figure 4-47—Oscillogram, Sweep Speed No. 3

Positions three and four of the RECEIVER switch are CAL. 1 and CAL. 2 respectively. They connect the top deflection plate of the cathode ray tube to the test circuits for counters No. 2 and No. 3. These positions are used only when adjusting the counter chain before operation, or to check the operation at any time. These test circuits will be described under auxiliary circuits.

w. 500 MICROSECOND AMPLIFIER.—The many circuits requiring a 500 microsecond timing pulse would heavily load the Second Counter if all were driven directly from it. More important, the voltage for tripping both the Time Corrector and the Coarse Delay circuits must be relatively large negative pulses, and the voltage wave from the counter is approximately equal positive and negative pulses. The output from the counter is therefore fed into the amplifier, and the amplifier decreases the size of the positive part of the wave with respect to the negative part.

The Amplifier circuit is shown in Fig. 4-48. The signal from the Second Counter is coupled to the grid of the Amplifier tube V116-1 by the isolating resistor R171,

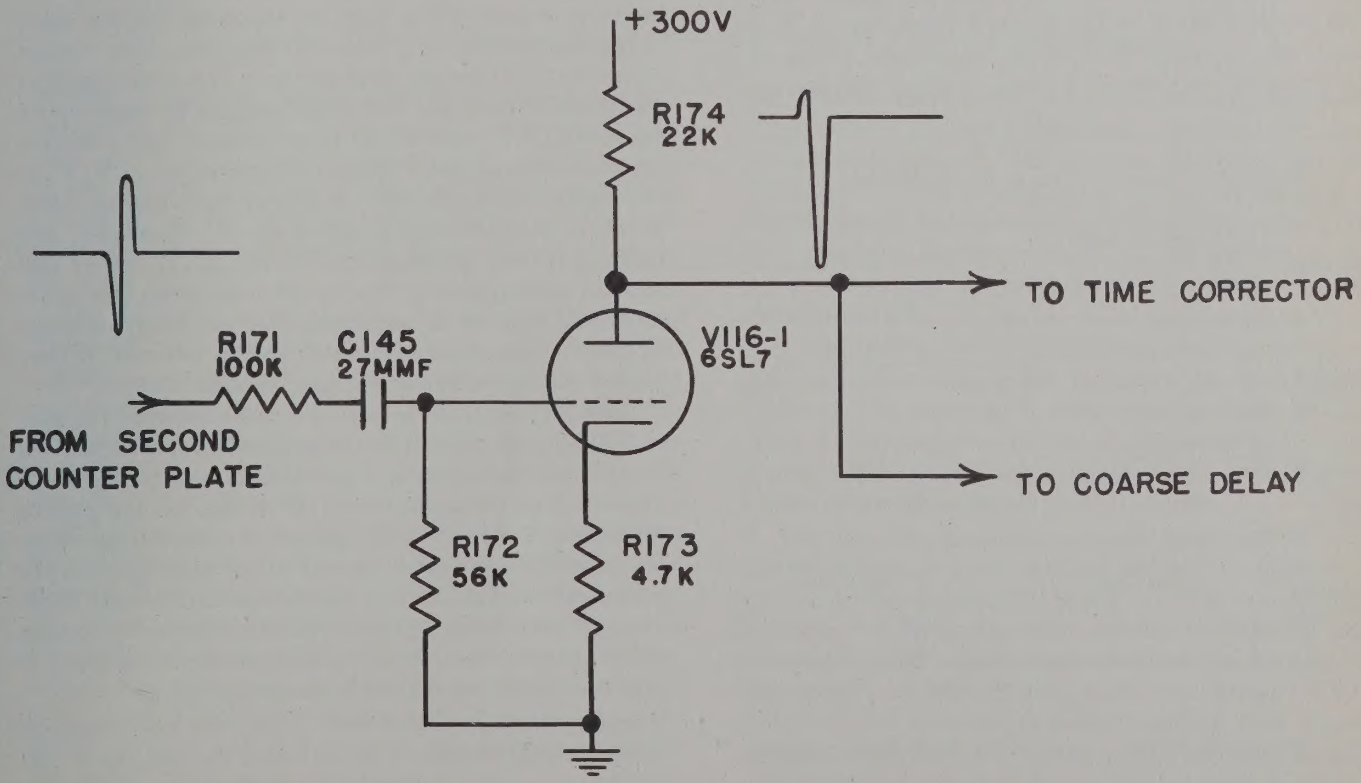


Figure 4-48—500 Microsecond Amplifier Circuit Diagram

and the capacitor C145. The combination of the grid leak resistor R172 and the cathode resistor R173 serve to bias the tube very nearly to cut-off voltage. This holds the voltage at the plate just below supply voltage.

When the sharp, negative-going pulse reaches the grid, the tube is entirely cut off, but the plate voltage can only rise to the supply voltage value. When the positive portion of the pulse reaches the grid, the tube immediately starts to conduct and the plate voltage drops sharply to about 90 volts. As the end of the pulse drives the grid back to normal, the plate returns nearly to the value of the supply voltage. This large negative pulse is coupled to the Time Corrector and Coarse Delay circuits.

x. "BALANCE" GAIN CONTROL.—When the distance to the Master transmitter is much greater or much less than the distance to the Slave station, or when other conditions make one signal much stronger than the other, the video signal patterns on the traces will be "unbalanced" in size, one being larger than the other. To balance them, in other words, to make the signals the same size, it is necessary to amplify one more than the other.

Both signals are amplified by the same receiver circuits, hence to amplify one and not the other it is necessary to act on the circuits in such a way that the gain is greater during the period of one trace than it is during the period of the other. The "balancing" of the gain then becomes a function of the timing, and for that reason the circuit belongs in the Indicator Unit.

Fig. 4-49 shows a normal sized Master signal as received on the A trace, and a smaller Slave signal as received on the B trace. Below it are the output waves from the two tubes of the Eccles-Jordan Square Wave Generator. By properly selecting one of the waves and regulating its magnitude, a positive-going voltage may be obtained during the period of either the A trace or the B trace. This voltage may be used to decrease the gain of the third I-F Receiver circuit during the positive swing, and thus reduce only the signal received in that period. This balances the signals so that when the GAIN control is turned up they will appear as shown at the bottom of Fig. 4-49.

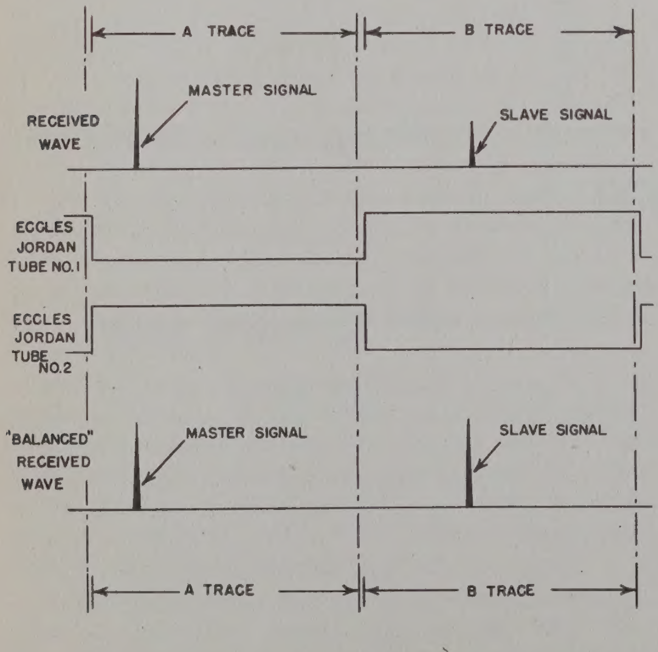


Figure 4-49—Balance Control Effect on Signals

The original Balance Gain Control circuit used is shown in Fig. 4-50. Later, after equipment Serial No. 404 the circuit was slightly modified, as shown on the schematic, Fig. 7-27, but its function was unchanged. The circuit selects the Eccles-Jordan square wave to be used, then regulates the amplitude of the wave and converts it to the form of a bias on the Third I-F Amplifier of the receiver. This amplifier is a variable mu tube, which means that, over a range, a change in bias will change the amplification factor of the tube.

The square waves from the generator are coupled to the high resistance voltage dividing circuits R158-R260 and R161-R241. The high resistance is to prevent the grids of the balance tubes, V112-1 and V112-2, from being driven into grid current very far and overloading the generator tubes. The modified circuit omits R260 and R241, increasing the signal strength. The two tubes, V112-1 and V112-2, are connected as identical cathode followers, with the potentiometer R160 bridging their cathodes.

The voltage at one end of R160 is a wave similar to the output from one Eccles-Jordan tube, and the voltage at the other end is similar to the output of the other Eccles-Jordan tube. The magnitude and shape of these waves, as shown in Fig. 4-49, are the same, but one wave is 180 degrees out of phase with the other. The voltage across R160 will vary with distance along the resistor, being positive on one end and changing to negative on the other. The center of the potentiometer will not show any square wave, but will be at the mean potential of the two ends. This means that starting at the center of R160, which is the BALANCE gain control adjustment, and rotating in one direction, one of the square waves will increase in magnitude. In the other direction, the other wave will increase in magnitude, the two being opposite in phase. The wave, whichever one is selected, is then passed through C141 to the grid of tube V113-1.

Tube V113-2 is connected as a diode between the grid of V113-1 and ground in the original circuit to prevent the grid from ever going negative with respect to ground. The effect of the square wave of voltage on the grid of tube V113-1 is to make it conduct current during either the A or B trace, or during neither, depending upon the setting of the BALANCE control potentiometer, R160. The capacitor C142 serves to round off the sharp corners of the square waves which would produce transients in the receiver due to the sudden change in gain.

In the modified circuit tube V113-2 has been removed from the grid circuit of V113-1, and the two tubes connected in parallel. A smaller cathode resistor, R165, was required to achieve the proper action on the Receiver stage, and V113-1 alone was unable to pull sufficient

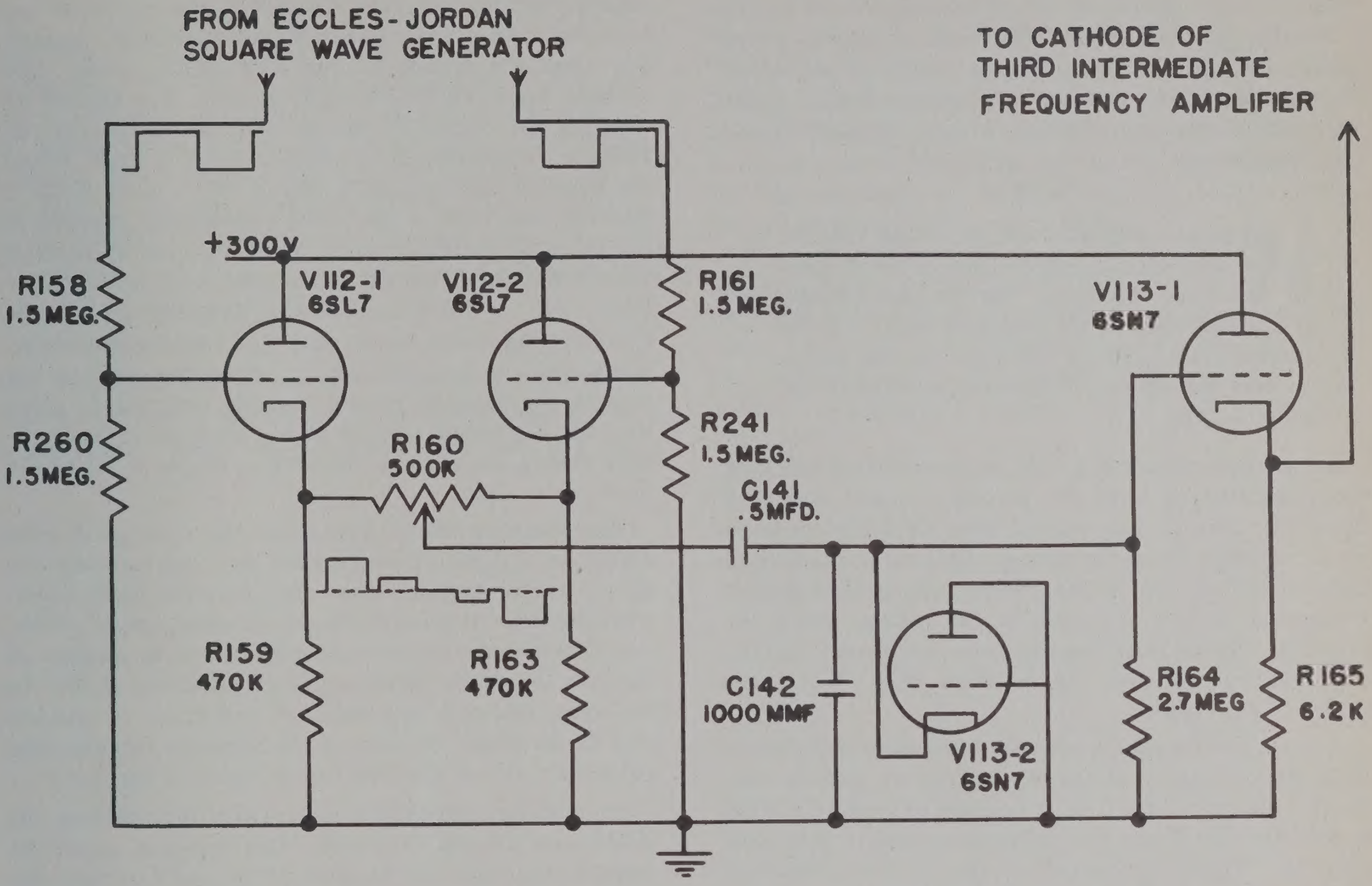


Figure 4-50—Balance Gain Control and Balance Control Circuit Diagram

current through the smaller resistor to give the desired change in bias. V113-2 was therefore connected in parallel wth V113-1, a 4700 resistor R137 was connected in parallel with R165, and the value of R165 was reduced to 4700 ohms. The modified circuit is shown on the complete Indicator Unit Schematic Diagram at the back of the book. (Fig. 7-27).

The cathodes of V113-1 (and V113-2) and of the Third I-F Amplifier tube in the Receiver Unit are tied together, so that the current through R165 (and R137) supplies cathode bias for both tubes. The I-F amplifier tube current alone, through R165 (and R137) produces a fixed bias on the tubes of about 25 volts, which is enough to cut off tube V113-1 (and V113-2) when its grid is at ground potential. This bias must be overcome by positive square wave signals on the grid before the tube conducts. For this reason there is a neutral area in the center of the Balance Control potentiometer before the square waves are large enough to overcome the bias. When the tube starts to conduct, its current through R165 (and R137) increases the cathode potential of the tubes, with a resulting increase in bias on the I-F Amplifier tube.

Increasing the bias on the variable-mu amplifier tube reduces the amplification during that period, so that if the square wave which goes positive during the A trace (Fig. 4-49) is selected by the Balance Control, the Master signal amplitude is reduced. Conversely, if the wave which goes positive during the B trace is selected, the Slave signal is reduced. Once the signals have been made the same size, the over-all gain of the Receiver may be used to regulate the magnitude of both video signals simultaneously.

y. CALIBRATION CIRCUITS.—When making the original adjustments to the Indicator Unit it is necessary to check the alignment of the counter chain. This consists of counting the number of pulses each counter receives before producing a pulse of its own. Fig. 4-16 shows the proper alignment of the chain.

The ten microsecond markers are at 100 kilocycles, crystal frequency (Fig. 4-29) and form a logical starting point. When the SWEEP SPEED switch is turned to the fastest sweep (No. 4 sweep), and the RECEIVER switch is turned to OFF, the 10 and the 50 microsecond markers are clearly visible on the oscilloscope screen. The 50 microsecond markers each represent a First Counter output pulse, and it becomes a simple matter to adjust the circuit so that five of the 10 microsecond intervals occur between First Counter output pulses. (One 10 microsecond marker will coincide with a 50 microsecond marker, and thus only four will be visible in the interval.)

Turning the SWEEP SPEED switch to a slower sweep (No. 3 sweep), it is possible to count on the lower trace the 50 microsecond markers between Second Counter, 500 microsecond markers, but the method is not very satisfactory.

Note

> It will be necessary to move the FINE DELAY so that two 500 microsecond markers will show on the trace. However, the Second Counter is the one affected by step feed-back, and the normal trace permits no check on this action because the shortened interval is blanked out (Fig. 4-22).

An auxiliary circuit, Fig. 4-51, is provided for checking the alignment of both the Second Counter and Step Feed-back circuits. The grid of tube V115-1 of this test circuit is connected to the storage capacitor in the Second Counter (C120, Fig. 4-10), making the grid-to-ground voltage of V115-1 the same as the voltage across the capacitor. As the First Counter pulses are stored, and the capacitor voltage goes up in steps (Fig. 4-11), the grid of V115 follows.

The calibration tube is connected as a cathode follower to minimize loading of the counter circuit, and the output is connected to the CAL. 1 position of the RECEIVER switch S102-B. When the switch is turned to this position, the signal is coupled to the vertical deflection plates of the cathode ray tube and will deflect the beam in steps. A special sweep, which lasts only as long as the variable Second Counter interval, is derived for this calibration from the Time Corrector circuit. This sweep has a duration of from 150 to 500 microseconds, depending upon the setting of the STATION switch. The number three SWEEP SPEED is used, but instead of tripping the Sweep Generator with the output of the Pedestal Generator, the Time Corrector is used. When the Receiver Switch (S102C, Fig. 4-38) is in the CAL. 1 position, one tube of the Time Corrector is coupled to the Pedestal Buffer in place of the Pedestal Generator. This is not the Time Corrector tube used for the slow trace (No. 1 SWEEP SPEED), but the other tube (V110-1, Fig. 4-20) whose output is 180 degrees out-of-phase with the first. Instead of starting the sweep at the end of the variable Second Counter interval, it starts it at the beginning; instead of blanking the cathode ray tube during the variable interval, it blanks it all of the time except then.

The resulting traces, one above the other, will each appear as a flight of stairs, each step representing one First Counter output pulse. The complete flight represents the interval between Second Counter output pulses, and it becomes a simple matter to count the number of steps in the flight. With no feed-back there should be ten steps, and each step fed back will result in one less step in the flight. Because of the slope on the blanking pulse only part of the first step is visible. (Fig. 3-7.)

An auxiliary circuit is also provided for checking the Third and Fourth Counters. Here again it would be possible to count the number of Second Counter, 500 microsecond markers between Third Counter, 2500 microsecond markers, and the number of 2500 micro-

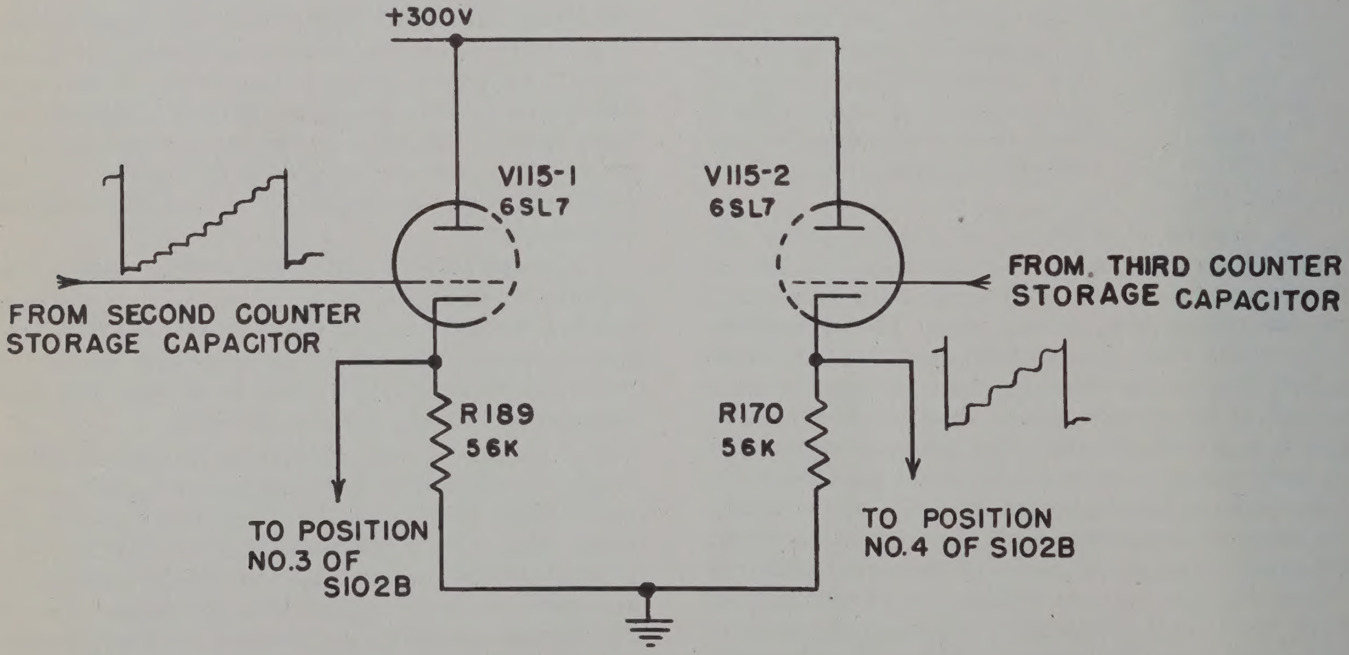

+300V
V115-1
6SL7
V115-2
6SL7
FROM SECOND COUNTER STORAGE CAPACITOR
FROM THIRD COUNTER STORAGE CAPACITOR
R189
56K
R170
56K
TO POSITION NO.3 OF S102B
TO POSITION NO.4 OF S102B

Figure 4-51—Second and Third Counter Calibration Circuit Diagram

second intervals in each trace by using the slow sweep, (SWEEP SPEED No. 1) but the chance of error is great, and therefore a CAL. 2 circuit is provided.

The tube V115-2, Fig. 4-51, functions exactly as the other calibration tube, except that its grid is connected to the storage capacitor (C123, Fig. 4-12) of the Third Counter. The output of this tube is connected through the CAL. 2 position of the RECEIVER switch, S102-B to the cathode ray tube vertical deflection plates. As the storage capacitor voltage goes up in steps, the trace on the oscilloscope will do the same.

The slow sweep is used in conjunction with CAL. 2, and the traces should therefore contain a number of flights of stairs. Each flight represents the interval between Third Counter output pulses, and each step corresponds to a Second Counter pulse. There should be five steps in each flight except the first, and it should have four.

The trace length represents the interval between Fourth Counter pulses, less the Second Counter output interval following the Fourth Counter pulse. This first interval is the one blanked out by the Time Corrector, and this accounts for the four steps in the first flight instead of five as in the other flights.

When the PRR switch is at L there should be eight flights of stairs on each trace. (See Fig. 3-10.) When the PRR switch is at H there should be six flights. (Fig. 3-11.) (If the equipment has not had the PRR switch installed, it will normally be adjusted for eight flights, corresponding to the L basic pulse recurrence rate.)

V. MAINTENANCE

1. PREVENTIVE MAINTENANCE SCHEDULE.

THE ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO THE REQUIREMENTS OF CHAPTER 67 or 68 OF THE "BUREAU OF SHIPS MANUAL", OF THE LATEST ISSUE.

LUBRICATION OF THIS EQUIPMENT IS NOT REQUIRED.

a. Daily—

Visual check of operation, including OPERATING ALIGNMENT CHECK (page 3-2). Check line voltage to POWER SUPPLY UNIT.

b. Weekly—

1. Go through complete MAINTENANCE ALIGNMENT OF INDICATOR AND POWER SUPPLY (page 5-3).
2. Inspect cathode ray tube for normal intensity trace.
3. Inspect traces for a-c hum.
4. Visual inspection of interior for loose parts, corrosion, water dripping, etc.
5. Clean antenna insulators and inspect Loading-Coil, antenna, and interconnecting cables.
6. Wipe dust off cabinet.

c. Monthly—

1. Check r-f alignment of Receiver on actual signals (page 5-7).
2. Blow dust out of equipment if an excessive amount has accumulated.
3. Test Receiver tubes and replace any which are weak.
4. Check crystal FREQUENCY control for ample range.

d. Quarterly—

1. Check bandwidth and sensitivity if a signal generator is available (page 5-9).

Check alignment of wave traps (page 5-9).

2. DESCRIPTION OF CONTROLS AND ADJUSTMENTS.

The number in parentheses following the title of the control refers to the front panel item number in Fig. 3-2.

a. ON-OFF POWER SWITCH (26).—Controls input power for the complete equipment. When in the OFF position, auxiliary heaters are connected to reduce effects of humidity and decrease warm-up time. The PILOT LIGHT (27) is on when ON-OFF switch is ON. The intensity can be controlled by turning the rim of the light. The FUSE (28) for the equipment is located next to the PILOT LIGHT.

b. CONTROLS FOR SELECTING THE DESIRED PAIR OF STATIONS.

(1) CHANNEL switch (19) (with positions 1 to 4) for selecting the desired radio frequency channel, as follows:

Channel No.	Factory Setting	Tuning Range
1	1.950 m.c.	1.70 m.c. to 2.075 m.c.
2	1.850 m.c.	1.70 m.c. to 2.075 m.c.
*3	10.58 m.c.	9.90 m.c. to 12.10 m.c.
*4	10.58 m.c.	9.90 m.c. to 12.10 m.c.

*Will have same range as channels No. 1 and 2 after the coil kit is added.

This switch is S401 (A, B and C) in the receiver and consecutively connects the four sets of channel tuning coils in the r-f circuit.

(2) PRR switch (31) (with positions L and H) selects a *basic pulse recurrence rate* corresponding to that of the desired pair of stations. This switch is supplied as a modification kit for the DAS equipments, which when modified are known as DAS-a. This switch is S105 in the Indicator Unit, and selects the cathode resistance to be used in the Fourth Counter. The resistance determines the counting ratio, and sweep repetition rate.

(3) STATION switch (8) (positions 0 through 7) selects the *specific pulse recurrence rate,* corresponding to that of the desired pair of stations. This is switch S104 in the Indicator Unit Step Feed-back circuit. For a complete description of this circuit and its action, see page 4-14.

c. CONTROLS FOR OBTAINING THE SEQUENCE OF OSCILLOSCOPE PATTERNS NECESSARY FOR A READING.

(1) RECEIVER switch (5) with four positions:
OFF: Signals from receiver *not applied* to scope.
ON: Signals from receiver *applied* to scope.
CAL. 1: Provides pattern to check alignment of Indicator (Second Counter adjustment "C2" and STATION selector switch.)
CAL. 2: Provides pattern to check alignment of Indicator (Third Counter adjustment "C3" and Fourth Counter adjustments "C4" or "C4A" and "C4B").
This switch is S102 (A, B and C) in the Indicator Unit. It not only determines which signals will be placed on the top deflection plate of the cathode ray tube (S102A and B), but also selects a special blanking (S102-C) for testing the STATION selector, or Feed-Back, circuit.

(2) SWEEP SPEED switch (7) with five positions:
POSITION 1: "Slow Sweep" (each trace shows nearly one-half of pulse recurrence interval.

Sweep length 19,500 microseconds on "L" PRR, 14,500 on "H" PRR). Wide trace separation.

POSITION 2: "Fast Sweep" of about 2300 microseconds duration. (Portions on top of pedestals of slow sweep expanded to entire screen width.) Medium trace separation.

POSITION 3: "Fast Sweep" of about 650 microseconds duration. (Left portion of each trace of number 2 sweep expanded to entire screen width.) Medium trace separation.

POSITION 4: "Fast Sweep" of about 160 microseconds duration. (Left portion of each trace of number 3 sweep expanded to entire screen width.) Medium trace separation.

POSITION 5: "Fast Sweep" same as position 4 except no trace separation.

This switch is S103 (A, B, C, D, and E) in the Indicator Unit. It not only controls the sweep speed (S103-B) but also selects the proper blanking (S103-A), trace separation (S103-D), pedestal width (S103-C), and LEFT-RIGHT control rate (S103-E).

(3) LEFT-RIGHT switch (12) for shifting the position of the signals on the traces. This is Indicator Unit switch S101-A which varies the Oscillator frequency; and S101-B which acts on the First Counter in much the same manner as the Feed-Back circuit acts on the Second Counter. An appropriate drift speed is automatically provided for the various sweep speeds by S103-E.

(4) FREQUENCY dial (17).—Adjusted to exactly stop slight drifting of received pulses when on the fast sweeps. This controls an air trimmer (C102) in the grid circuit of the Indicator Unit oscillator.

(5) COARSE DELAY control (24).—Moves the lower pedestal in jumps of 500 microseconds. Although the control is located on the Power Supply panel, it is an Indcator Unit control. It is the bias potentiometer for tube V119-1, described on page 4-30, 31.

(6) FINE DELAY control (25).—Moves the lower pedestal smoothly by intermediate amounts. This is also an Indicator Unit control, similar to the COARSE DELAY. It is the bias potentiometer for tube V126-1, described on page 4-33.

(7) GAIN control (13).—Adjusts the amplitude of signals on the scope by controlling the bias on the first four stages of the Receiver. The potentiometer is located in the Indicator (R214).

(8) BALANCE control (14).—Balances the amplitude of pulses on the upper and lower traces. This is potentiometer R160 in the Indicator Unit, described in detail on page 4-44.

(9) FILTER "IN-OUT" switch (18).—Used for reducing certain kinds of interference. (Normally used in the OUT position.) This switch is S402 in the Receiver Unit.

d. SCREWDRIVER CONTROLS FOR ADJUSTING THE QUALITY OF THE PATTERN ON THE CATHODE RAY TUBE ("SCOPE") FACE.

(1) FOCUS (6) controls first anode voltage of cathode ray tube (R230) and regulates sharpness of pattern obtained.

(2) INTENSITY (9) controls voltage on cathode ray tube grid (R233) and regulates brightness of pattern.

(3) ASTIGMATISM (4) controls second anode voltage of cathode ray tube (R221) to correct for defocussing of spot at ends of sweep.

(4) HOR. CENT. (1) for shifting the entire Oscilloscope pattern right or left. (Inside cabinet on left side of Indicator for Models DAS-a and DAS-2; front panel on Model DAS.) Acts in cathode of Sweep Amplifier to control the average voltage of its output (R252).

(5) VERT. CENT. (2) for shifting the entire oscilloscope pattern up or down (inside cabinet on left side of indicator for Models DAS-a and DAS-2; front panel on Model DAS). Acts on lower deflection plate of cathode ray tube (R218).

e. MARGINAL CONTROLS WHICH SHOULD BE SET IN THE MIDDLE OF THEIR STABLE RANGE DURING ROUTINE MAINTENANCE CHECKS. (SCREWDRIVER ADJUSTMENTS.)

(1) R143, TIME CORRECTOR located on the back of the rear apron of the Indicator chassis—varies the bias on the cathode of the Time Corrector tube, V110-2.

(2) R148, E. J. BIAS, on the center-left of Indicator chassis, varies the bias of the cathode of the Eccles-Jordan tube, V111-1, and controls the trace separation.

(3) "C1" (10) controls the counting ratio of the First Counter, and thus the number of ten microsecond markers between 50 microsecond markers. It is R114 in the cathode of the First Counter in the Indicator Unit.

(4) "C2" (15) controls the counting ratio of the Second Counter, and thus the number of 50 microsecond markers between 500 microsecond markers. It is R120 in the cathode of the Second Counter.

(5) "C3" (11) controls the counting ratio of the Third Counter, and thus the number of 500 microsecond markers between 2500 microsecond markers. It is R126 in the cathode of the Third Counter.

(6) "C4" or "C4A" (16) controls the counting ratio of the Fourth Counter when PRR is on "L" (equipments with no PRR switch are inherently set to "L") and thus the number (eight) of 2500 microsecond markers per trace or sweep. This gives the sweep period, or *BASIC* recurrence rate. It is R132 in the cathode of the Fourth Counter.

(7) "C4B" (32) is an alternate for "C4" or "C4A" and appears only on Models DAS-a and DAS-2. This controls the counting ratio when PRR is on "H", and gives six 2500 microsecond markers per trace. It is R186 in the cathode of the Fourth Counter.

(8) STATION or FEED-BACK TRIMMERS located below the cathode ray tube shield, in front of

the vertical chassis. These trimmers are consecutively connected in the Feed-Back circuit as the STATION switch is advanced from 0 through 7. They control the length of the first Second Counter interval in each sweep as observed on RECEIVER CAL. 1 and SWEEP SPEED 3, and thus the *SPECIFIC* recurrence rate of the sweep.

(9) C119 2ND COUNTER, on center right of the Indicator chassis, varies the size of the input pulse from the First to the Second Counter, and hence the range the STATION or feed-back trimmers may cover.

(10) R202, FIXED DELAY on the front-left center of the vertical chassis of the Indicator Unit—varies the potential on the first grid of the Fixed Delay multivibrator and the delay time for the top pedestal, as described on page 4-25.

(11) R308 VOLTAGE CONTROL, on the left-rear of the Power Supply chassis—varies the regulated power supply output voltage.

f. CONTROLS WHICH NEED ADJUSTING ONLY WHEN INDICATED BY AN INSPECTION OF THE "SCOPE" PATTERN OR EQUIPMENT.

(1) LO-FINE DELAY (22), to the upper left of the FINE DELAY control, determines the minimum setting (150 microseconds) of the Fine Delay circuit. It is R337 mounted on the Power Supply panel.

(2) HI-FINE DELAY (23), to the upper right of the FINE DELAY control, determines the range (650 microseconds) of the control by fixing the maximum setting of the Fine Delay circuit. It is R335, mounted on the Power Supply panel.

(3) LO-COARSE DELAY (20), to the upper left of the COARSE DELAY control, determines the minimum setting (2000 microseconds) of the Coarse Delay circuit. It is R333, mounted on the Power Supply panel.

(4) HI-COARSE DELAY (21), to the upper right of the COARSE DELAY control, determines the range (10,500 microseconds) of the control by fixing the maximum setting (12,500 microseconds) of the Coarse Delay circuit. It is R331, mounted on the Power Supply panel.

(5) R103, PIP ALIGN, on the front-center of the Indicator Unit chassis, directly behind the front panel. Shifts the 10 microsecond markers by approximately plus or minus two microseconds along the trace so that they may be aligned with the 50 microsecond markers. This is the Phase Set circuit explained on page 4-24.

(6) R270, PEDESTAL, on the front-left center of the vertical chassis of the Indicator Unit. It controls the potential on the grid of the Pedestal Generator tube V128-1, and thus the length of the pedestal (2300 microseconds).

Note

Since the traces on the fast sweep speeds are a portion of the top of the pedestal, a change in pedestal length will give a change in the sweep length on all settings of the SWEEP SPEED switch except position 1.

(7) R250, SWEEP 1, on the upper rear bracket of the vertical chassis of the Indicator Unit, varies the length of the number 1 SWEEP SPEED trace on the cathode ray tube.

(8) R248, SWEEP 2, on the upper rear bracket of the vertical chassis of the Indicator Unit, varies the length of the number 2 SWEEP SPEED trace on the cathode ray tube.

(9) R247, SWEEP 3, on the upper rear bracket of the vertical chassis of the Indicator Unit, varies the length of the number 3 SWEEP SPEED trace on the cathode ray tube.

(10) R246, SWEEP 4, on the upper rear bracket of the vertical chassis of the Indicator Unit, varies the length of the number 4 and 5 SWEEP SPEED trace on the cathode ray tube.

(11) R182, TRACE SEPARATION, on the rear left of the Indicator chassis, varies the distance between the traces on the cathode ray tube; effective only on SWEEP SPEED No. 4.

(12) C177, TRACE BALANCE, on the rear of the Indicator chassis, varies the relative length of the two traces on the fast sweeps. It controls the size of the pulse from the Fine Delay used to trip the Pedestal Generator.

g. FACTORY ADJUSTMENTS TO TAKE UP MANUFACTURING TOLERANCES.

(1) L101, Crystal Range Set, on the front-right of the Indicator chassis, is a variable inductance used to compensate for stray capacitance in the Crystal Oscillator circuit.

(2) L103 Phase Shifter for Ten Microsecond Markers, on the front-right of the Indicator chassis, is a variable inductance used to take up capacity tolerances in the Phase Shift network, and thus adjust for range of the PIP ALIGN. adjustment.

h. ANTENNA LOADING-COIL ADJUSTMENT (TO BE MADE ONLY WHEN INSTALLING ANTENNA OR CHANGING RECEIVER TUNING FREQUENCIES).

The coil is provided with taps so that any number of turns can be connected in series with the antenna. The number of turns between taps is marked on the terminal board, and a table of approximate turns for any length antenna is provided on the inside of the Coil Box cover. The correct number of turns will practically tune out the residual reactance of the antenna.

i. RECEIVER R-F ADJUSTMENTS (OSC., CONV., AND ANT.).

(1) L408, L412, and L416 are located in the coil box just behind the Receiver front panel, and are the screwdriver controls marked with a "1". They tune Channel No. 1.

(2) L407, L411, and L415 are similar to Channel 1 controls, but are marked "2" and tune Channel No. 2.

(3) L406, L410, and L414. Similar to above, but marked "3" for Channel No. 3.

(4) L405, L409, and L413. Channel No. 4 tuning coils, marked "4". Also located in coil box behind the front panel.

j. RECEIVER I-F ADJUSTMENTS.—T401, T402, T403, T404 are all i-f transformers located on the top of the tube chassis of the Receiver. The screwdriver adjustments are provided for tuning each transformer.

k. RECEIVER WAVE-TRAP ADJUSTMENTS.—L401, L402, and L403 are located on top of the tube chassis of the Receiver and just behind the front panel. These three screwdriver adjustments tune the inductances of the Wave Traps.

3. MAINTENANCE ALIGNMENTS.

WARNING—HIGH VOLTAGES (2000 VOLTS) ARE PRESENT IN THE CATHODE RAY TUBE AND POWER SUPPLY CIRCUITS WHENEVER THE POWER SWITCH IS "ON".

All high voltages are above the main chassis of the units, and in the interconnecting wires. Use extreme caution when making adjustments.

a. MAINTENANCE ALIGNMENT OF POWER SUPPLY UNIT.—Check the line voltage to the Power Supply Unit.

(1) The equipment is designed to operate on either 115 volts ±10 volts, 50 to 60 cycles per second, or 230 volts ±20 volts, 50 to 60 cycles, per second.

(2) If the supply is 115 volts, switch S302 which is located at the left-rear of Power Supply chassis should be thrown to "115 VOLTS". If the supply is 230 volts, make sure that the switch is thrown to "230 VOLTS".

(3) A supply of FUSES of two ratings will be found behind the right side of the front panel to the right and top of the transformer T302. If the supply voltage is 115, select the 5 amp. fuse; for 230 volt operation, select the 2 amp. fuse. Put the correct fuse into the fuse holder.

(4) Connect the power cable to the line and throw the power switch to "ON". The pilot light should glow.

(5) The power supply adjustment R308 is made quite accurately at the factory and no further adjustment should have to be made. To check the regulated voltage, however, voltmeter prods can be inserted beneath the protective bakelite cover over the terminal boards on the left side of the unit and contact made with the +300V terminal. If the voltmeter reads 300 volts or slightly less for a line voltage of 115 v. or more, nothing need be adjusted.

At line voltages below 115 v., it is necessary to make a voltage adjustment to get the best stability and protect the rectifier tube V301. In this case, the voltmeter should be attached to the +300V point and ground, and the adjustment control should be varied to give a reading of 280 volts. The voltmeter reading should always be 300 volts or less, never more than 300 volts.

(6) When the Power Supply switch is thrown "OFF", two space heaters are automatically turned on. These heaters, located on the right side of the Indicator and Receiver Units, keep the equipment dry during stand-by periods and also minimize the receiver and crystal drift when the equipment is first turned on. These heaters are operated in parallel on 115 volts and in series on 230 volts. Check the heaters to be sure they heat when the power switch is turned to "OFF".

b. MAINTENANCE ALIGNMENT OF INDICATOR UNIT.—Quickly go through the OPERATING ALIGNMENT CHECK (page 3-2) to get an over-all picture of how well the equipment is functioning and to observe any major defects in the operation.

(1) FRONT PANEL CONTROLS which may get out of adjustment from day to day.

(a) On DAS equipments (before installation of the PRR switch) HOR. CENT. and VERT. CENT. screwdriver controls are located on the front panel. On DAS-a and DAS-2 equipments, these controls have been moved to the interior of the cabinet, at the upper left-hand front corner of the Indicator Unit. These controls vary the position of the whole pattern on the screen. With the SWEEP SPEED control on position 2, adjust HOR. CENT. so that the pattern is in the center of the screen in a horizontal direction.

Note

If the HOR. CENT. control is turned too far, the sweep may become too non-uniform at the ends (markers crowded together). This condition can be avoided because there is sufficient range of control before this region is reached.

Then turn the SWEEP SPEED switch through all positions to check the centering on all sweeps. If some are off to one side, a compromise setting of HOR. CENT. should be made. The VERT. CENT. control should then be adjusted so that approximately 1 3/4" of pulse height on top of the traces can be tolerated without going off the screen at the top.

(b) The quality of the pattern on the cathode ray tube screen is adjusted by means of the INTENSITY, FOCUS and ASTIGMATISM controls. Set SWEEP SPEED to position 1, and adjust INTENSITY and FOCUS simultaneously for a sharp, clear pattern. Various settings of the ASTIGMATISM control should be tried to secure the best over-all focus in all portions of the pattern. The final pattern should have very clear and distinct time markers showing.

(c) Control "C1" controls the ratio of the First Counter, and determines the number of 10 microsecond intervals between 50 microsecond markers, as seen on SWEEP SPEED 4 with RECEIVER control OFF. "C1" should be set in the center of the range where the correct pattern of five 10 microsecond intervals between 50 microsecond markers is obtained. (See Fig. 3-6, page 3-3.)

(d) Control "C2" controls the ratio of the Sec-

ond Counter, and determines the number of steps seen on SWEEP SPEED 3, with RECEIVER control on CAL. 1, and STATION switch on 0. "C2" should be set in the center of the range where the correct pattern of 10 steps is obtained. (See Fig. 3-7, page 3-3.)

(e) Control "C3" controls the ratio of the Third Counter, and determines the number of steps in each group, as seen on SWEEP SPEED 1 with RECEIVER control on CAL 2. This control should be set in the center of the range where the correct pattern of five steps in each group (except four steps in the first group) is obtained. (See Fig. 3-10, page 3-4.)

(f) Models DAS and DAS-a have a control "C4" and Model DAS-2 has a corresponding control "C4-A". In the DAS, control "C4" is in the circuit at all times and in the DAS-a and DAS-2 the control is in the circuit when the PRR switch is set to "L". This control determines the dividing ratio of the Fourth Counter, which determines the number of groups of steps as seen on SWEEP SPEED 1, with the RECEIVER control on CAL. 2. With the PRR switch, if any, set to "L", this control should be set to the center of the stable range where the correct pattern of eight groups of steps is obtained. (See Fig. 3-10, page 3-4.)

(g) In Model DAS-a and DAS-2, control "C4B" determines the dividing ratio of the Fourth Counter when the PRR switch is set to "H". This determines the number of groups of steps seen with the same SWEEP SPEED and RECEIVER switch settings as above. The control should be set to the center of the stable range where the correct pattern of six groups of steps is obtained. (See Fig. 3-11, page 3-4.)

Note

> In *some* DAS equipments the range of adjustment of "C4" is sufficient to allow adjustment to the "H" PRR pattern of six groups of steps if it is desired to receive stations operating at the "H" PRR and no switch is installed.

(h) If actual signals are available, turn up GAIN and adjust STATION and PRR to stop a pulse; then check to see if the LEFT-RIGHT control drifts the pulse at the same speed to the left and to the right on SWEEP SPEED 1. If it does not, readjust "C1" very *slightly* to produce such action. Then check (but do not bother to readjust unless incorrect) through steps (*c*), (*d*), (*e*), (*f*) and (*g*). If the alignment of 10 and 50 microsecond markers is not correct, it may be possible to find a compromise setting of "C1" which will produce correct marker alignment and still provide the correct LEFT-RIGHT action on the SWEEP SPEED 1. If not, there is need for internal adjustment of the Indicator (see pages 5-5, 6).

(i) The range of the FINE DELAY control is adjusted by the HI and LO screwdriver controls adjacent to the knob, as follows: Set the RECEIVER switch to OFF, the SWEEP SPEED switch to position 3, and the FINE DELAY knob fully counterclockwise. Turn the LO control counterclockwise until the lower or "B" trace disappears, then turn it clockwise until the trace reappears, and continue turning until two 50 microsecond markers on the lower trace have moved past the 500 marker on the upper trace, and stop turning on the third marker. Then slowly turn the FINE DELAY knob fully clockwise, and 12 additional 50 microsecond markers on the lower trace should move past a 500 microsecond marker on the upper trace. If more than 13 or less than 11 markers move past, readjust the HI adjustment until the correct number is obtained. This gives the FINE DELAY knob a range of about 650 microseconds. There is nothing critical about the adjustment of HI and LO, as long as a total range of at least 500 microseconds is covered, however a range of about 650 microseconds makes for more convenient operation.

(j) The range of the COARSE DELAY control is adjusted by the HI and LO screwdriver controls adjacent to the knob, as follows: Set the SWEEP SPEED to position 1, and the COARSE and FINE DELAY knobs fully counterclockwise. The left edge of lower pedestal should then be at the first 2500 microsecond marker, approximately. If it is not, adjust LO until it is. Then turn the COARSE DELAY fully clockwise, and the pedestal should move over to slightly past the fifth 2500 microsecond marker. If it does not, adjust HI until it does.

(2) MARGINAL CONTROLS which must be set in the middle of their stable range to prevent "on the edge" adjustments.

(a) The TIME CORRECTOR control R143 should be set in the middle of the range which gives a pattern like Fig. 3-7 with SWEEP SPEED on 3, RECEIVER on CAL. 1, and STATION on 0. Turning the control through the entire range will make it quite clear what patterns occur when this adjustment is wrong.

(b) The Eccles-Jordan Square Wave Generator produces the trace separation on SWEEP SPEED switch positions 1 through 4 (RECEIVER "OFF"). Turn the E.J. BIAS, R148, in both directions to where the trace separation stops, and then set the control at the middle of this range.

(c) The STATION switch selects pairs of capacitors; a fixed ceramic and an air trimmer in parallel to act as a voltage divider to feed back energy from the Fourth Counter to the grid of the Second Counter. The amount of voltage fed back by these capacitor pairs is somewhat variable by means of the air trimmer, but the range, particularly in the last few steps of the STATION switch, is not very great.

C119, SECOND COUNTER located on the right-center deck of the indicator, is the coupling capacitor from the First Counter to the Second Counter grid circuit, and its setting determines the size of the voltage increment fed into the Second Counter grid by voltage divider action. The STATION switch capacitors must feed into this circuit voltage increments which are multiples of the incremental voltage fed in by C119. Thus, with the STATION switch in No. 1 position, a voltage increment exactly equal in size to that from C119 is fed into the circuit; with the switch in No. 2 position, a voltage equal to two times the C119 incremental voltage is fed back, and so on up to step seven, when the voltage fed back is equal to seven times the incremental voltage fed into the grid of the Second Counter by C119. Since the voltage increments fed back from the STATION switch are more or less fixed, it is necessary to vary C119 to make its incremental voltage match those of the STATION switch. When C119 is varied, the sum of the increments placed on the grid of the Second Counter varies, and since it is desired that 10 of these cause the tube to fire, the cathode adjustment of V105-1, R120 ("C2") must be varied simultaneously to keep the stage counting at ten.

The STATION, or Feed-Back, trimmers are C151, C152, C154, C156, C158, C160, and C162. Turn the SWEEP SPEED switch to "3", the RECEIVER to "CAL. 1", and the STATION to "0". The pattern shown in Fig. 3-7, with ten steps on each trace, should appear. Advance the STATION to "7" and just the first three steps of each trace should be visible, as in Fig. 3-8. If the number is not correct, adjust C162 to give three if possible. If it is not possible to get three steps, set C162 in the middle of its range and adjust C119. When the proper number of steps have been obtained, turn the STATION back to "0" and if necessary readjust "C2" for ten steps.

Next advance the STATION switch through all eight positions ("0" through "7") and check the traces for the right number of steps. Adjust only the STATION or Feed-Back trimmers. The following table gives the STATION position, the air trimmer to be adjusted, and the number of steps which should be on each trace. (The sum of the number on the STATION switch plus the number of steps is always equal to ten.)

STATION Switch Position	0	1	2	3	4	5	6	7
TRIMMER Affected	None	C151	C152	C154	C156	C158	C160	C162
Number of STEPS	10	9	8	7	6	5	4	3

After adjusting, tighten the locknuts on the trimmer shafts.

(d) FIXED DELAY, R202. The presence and position of the "A" pedestal is dependent upon the proper firing of the 2000 microsecond Fixed Delay Multivibrator, V120. If this stage is not firing, the pedestal will not appear. If the location of the pedestal is incorrect (its front edge is not coincident with the first 2500 microsecond marker on the upper trace), it will be necessary to adjust the FIXED DELAY control, R202, on the front-left center of the vertical chassis. First turn the control counterclockwise all the way; then turn it slowly in a clockwise direction until further turning does not cause the pedestal to advance to the right. Note this setting of the control and continue turning until the pedestal suddenly jumps to the right. Note this position and finally set the control mid-way between the two positions.

(3) INTERNAL CONTROLS *to be adjusted only when Inspection Indicates Need.* These adjustments may not have to be made from one month to another, but after any have been made, the adjustments in the preceding sections should be rechecked.

(a) The time duration of the fast traces, while not of vital importance, has been found to give the best results when the sweep produced with the SWEEP SPEED switch in No. 2 position produces a sweep of 2300 microseconds (four 500 plus an additional six 50 microsecond markers on the top trace). This will give approximately 650, and 160 microsecond sweeps in SWEEP SPEED No. 3 and No. 4 respectively. If the second sweep is different from 2300 microseconds, R270 PEDESTAL, which varies the length of all three fast sweeps simultaneously, should be adjusted to give this time.

(b) SWEEP LENGTH.—Having set the sweep time correctly, the length of the trace on the cathode ray tube should then be adjusted. In general, it is desirable to have the sweep between three and three and one-half inches long, although the best length can be determined by the operator.

1. With the SWEEP SPEED switch on No. 1 position, the "slow sweep" will appear on the cathode ray tube. The length of this sweep is varied by the adjustment of R250, a potentiometer mounted on a special bracket behind the vertical chassis of the Indicator Unit. The bracket is marked SWEEPS, and R250 is numbered "1", denoting that it is the sweep control for the first sweep. Loosen the screw in the shaft-locking mechanism and adjust the control to give the desired sweep. Tighten all shaftlocks when adjustment is complete.

2. Turn the SWEEP SPEED switch to position No. 2 and adjust R248, which is on the same bracket and labeled "2". This control should be adjusted to give approximately 3 1/2 inches of sweep.

3. In like manner, the SWEEP SPEED switch should be turned to position No. 3 and R247 marked "3" adjusted to give approximately 3 1/2 inches of sweep.

4. With the SWEEP SPEED switch in position No. 4, adjust R246 marked "4", to give approximately 3½ inches of sweep.

(c) TRACE BALANCE control is accomplished on the fast sweep. The control C177, marked TRACE BALANCE, is located on the rear center of the indicator chassis, to the rear of the vertical chassis. With the SWEEP SPEED switch on position No. 4, turn the adjustment screw on C177, and vary the length of the bottom trace with respect to the top trace until the two traces are equal.

(d) TRACE SEPARATION. The 50 microsecond markers on the upper, or "A" trace, are used as

pointers to read time off the bottom or "B" trace on SWEEP SPEED "4". To facilitate these readings, the bottom tips of the 50 microsecond markers on the upper trace should just touch the top of the 10 microsecond markers on the lower trace. To adjust the traces so that this condition is met, vary R182 TRACE SEPARATION control located on the deck of the Indicator Unit and just behind the vertical chassis.

(e) PIP ALIGN, R103.—With the SWEEP SPEED switch in No. 4 position, the alignment of the 10 microsecond markers with respect to the 50 microsecond markers should be checked. It is important that the 10 microsecond markers be exactly coincident with the 50 microsecond markers. To determine the coincidence, turn to SWEEP SPEED 5 and adjust the FINE DELAY until the 10 microsecond markers of one trace are superimposed on the 10 microsecond markers of the other trace, ignoring where 50 microsecond markers occur. Then turn to SWEEP SPEED 4 and the tip of the 50 microsecond markers on the top trace should point to the tip of 10 microsecond markers on the bottom trace. If coincidence of the markers, as indicated above, occurs in the center of the stable range of the First Counter "C1" adjustment, nothing need be done; but if the coincidence does not occur in the center of the counter range, then it will be necessary to adjust R103 PIP ALIGN, a potentiometer just behind the front panel of the Indicator Unit. Set the counter in the middle of its stable range and adjust the PIP ALIGN. control to give coincidence of the markers.

(4) FACTORY ADJUSTMENTS *Which Should NOT be Readjusted if it Can be Avoided.*

(a) The PHASE SHIFT coil L102 is used in conjunction with R103, to align the 10 microsecond markers with the 50 microsecond markers by shifting the phase and hence the timing of the 10 microsecond markers with respect to the 50 microsecond markers. If it becomes necessary to adjust this coil because the PIP ALIGN. has insufficient range, proceed as follows:

1. Adjust "C1" to give equal drifting of the pulses in either direction when the LEFT-RIGHT switch is manipulated.

2. Turn the SWEEP SPEED switch to position No. 4.

3. Turn R103 PIP ALIGN. located on the front-center of the Indicator chassis counterclockwise to increase the resistance to maximum, and note which way the 10 microsecond markers move on the cathode ray tube screen.

4. Heat the adjusting stud on L103 with a soldering iron until the sealing wax is soft enough to allow the stud to be turned.

5. Turn the stud with a screwdriver so as to move the 10 microsecond markers in the same direction as in *2* above.

6. Stop turning the stud of L102 as soon as no further movement in these 10 microsecond markers is noticed.

7. R103 should now have its proper range for adjusting the 10 microsecond markers.

(b) L101.—The oscillation frequency of the quartz crystal tends to increase after the crystal has been in operation for a length of time. Should this change in frequency with age become excessive so that the FREQUENCY dial on the Indicator panel runs off center and be at the end of its range when signals are being received and synchronized, the crystal grid coil, L101, located on the front-right of the Indicator Unit chassis should be adjusted as follows:

1. Set the SWEEP SPEED switch to position No. 1.

2. Choose a pair of air signals on the screen, and set the STATION switch to make these signals stationary on the screen.

3. Set the FREQUENCY dial to number 7.

4. Heat the stud of L101 with a soldering iron until the sealing wax becomes soft.

5. Turn the stud with a screwdriver until the pulses appear stationary on the screen.

6. The pulses should then be placed on top of the pedestals and the SWEEP SPEED switch turned to position No. 2.

7. For fine adjustment, L101 should again be adjusted as above until the pulses stand still on the trace. The frequency dial is now at the center of its range.

(5) NOTES ON INDICATOR ADJUSTMENT.

(a) Before starting to align the Indicator Unit, obtain a stable trace on the "scope" if it is possible. If the trace tends to be "jittery", check the COARSE DELAY control, then the counter adjustments, for a stable setting.

(b) In the case of long traces which run off the screen of the cathode ray tube on SWEEP SPEED No. 1, before starting an adjustment either shorten the traces by means of the SWEEP adjustments, or, if possible, move the pattern back on the screen by means of the HOR. CENT. control.

(c) All of the Indicator checks and adjustments, except the FREQUENCY control and the LEFT-RIGHT switch, may be made without Receiver signals being present.

c. MAINTENANCE ALIGNMENT OF THE ANTENNA LOADING-COIL UNIT (to be made only when installing a new antenna, or changing the receiver tuning frequency).

(1) GENERAL.

A fine adjustment of the connections in the Antenna Loading-Coil is necessary for best performance of the Receiver. Since there is a certain amount of interaction between the Receiver tuning and the Antenna Loading-Coil tuning, the following instructions should be carefully followed for optimum results. It will be noted that the Loading-Coil is intended to operate only in the 1.7 to 2.075 mc. band.

Make sure that the antenna lead-in wire is connected to the terminal in the "beehive" ceramic insulator and that the inner conductor of the coaxial cable is not short-circuited to the coil box. Remove the antenna connector from the receiver when checking for the short circuit because the receiver input circuit is coupled to ground.

Determine the approximate length of the antenna, including the lead-in wire. Refer to the table printed on the inside of the Antenna Box cover, and determine the approximate number of turns required to resonate the antenna. This table was determined on the basis of a vertical wire in free space against a perfect ground. Variation from these conditions will vary the amount of loading required.

The Antenna Loading-Coil is a continuous wound coil tapped so that any multiple of two turns can be selected by proper connections. The figures between adjacent terminals indicate the number of turns between the terminals. Connect the two unconnected leads to the proper terminals so that the total number of turns between these terminals (as given on the terminal board) equals the number of turns given on the cover table, but do not solder the wires in place.

(2) TUNING ON ACTUAL SIGNALS.

Actual Loran signals provide the best means for aligning the Antenna Loading-Coil. The Indicator should be set to show stationary signals from the desired channel. The received pulse should be placed on the bottom pedestal, and the SWEEP SPEED turned to position 2. The top trace will then provide a convenient reference line for judging the relative height of the pulse as the tuning is varied. A steady ground wave pulse is to be preferred. The number of Antenna Loading-Coil turns should be varied in steps of two turns until the maximum pulse height is obtained. Then vary the "antenna" tuning in the Receiver to see if the pulse height can be still further increased. Then try several multiples of two turns less and multiples of two turns more, and in each case retune the "antenna" adjustment in the Receiver for maximum pulse height. When the best combination of Loading-Coil turns and "antenna" tuning adjustments have been chosen, the connections in the Loading-Coil should be soldered. If very strong signals are available, the above procedure can be simplified by inserting a 500 or 1000 ohm resistor in series with the antenna lead at the Receiver, and then peaking the "antenna" adjustment. The number of Loading-Coil turns found to produce best results with this "antenna" adjustment will probably be the optimum number as found by the trial-and-error procedure described above.

When reception of several channels in the 1.7 to 2.075 mc band is necessary, a compromise adjustment of the Loading-Coil must be made. If it is desired to receive signals on, for example, 1.75, 1.85 and 1.95 mc, peak the Loading-Coil on the 1.85 mc channel and then tune the "antenna" adjustments of the other two channels for best possible performance with this Loading-Coil adjustment. If no signals at a center frequency are available, such as when operation is desired at only 1.85 and 1.95 mc, the best procedure is to peak the "antenna" and Loading-Coil adjustments for each channel separately, then set the Loading-Coil at the average number of turns and readjust each "antenna" adjustment for best performance.

(3) TUNING WITH SIGNAL GENERATOR.

If actual signals are not available, the tuning may be accomplished by connecting a modulated signal generator to another antenna aboard ship or near-by, and tuning on these signals. The modulation pattern on the scope of the Indicator will afford a tuning indication. For methods of using an unmodulated signal generator, see the *Maintenance Alignment of the Receiver Unit.*

(4) TUNING ON RECEIVED NOISE.

If actual signals or a signal generator are not available, a preliminary adjustment of the Loading-Coil may be made by tuning for maximum received noise. This should not be confused with the inherent noise or "grass" generated by the Receiver. A final adjustment should be made by better means when available.

d. MAINTENANCE ALIGNMENT OF THE RECEIVER UNIT.

(1) ALIGNMENT OF THE R-F STAGE ON ACTUAL SIGNALS.

A good check of the R-F Stage alignment can be made without the use of any test equipment by tuning in on actual Loran signals. Turn the Receiver-Indicator on, and be sure the Indicator Unit is functioning properly. On new installations the Antenna Loading-Coil should be adjusted or "peaked" first.

Turn to SWEEP SPEED "1" and RECEIVER "ON" and manipulate the CHANNEL, PRR, STATION and LEFT-RIGHT controls until a pulse from the desired transmitter is visible on the upper pedestal.

(a) Withdraw the Receiver Unit chassis to the inspection position and locate the three sections of the r-f coil box. Starting with the OSC. coil which has the same number as the CHANNEL switch position to which the set is tuned, turn the screwdriver adjustment to give maximum amplitude to the pulse signal on the scope.

(b) Second, adjust the CONV. coil which has the same number as the OSC coil just tuned. Again adjust for the maximum pulse amplitude.

(c) Tune the ANT. coil for the channel, and follow the same procedure as before.

(d) If a second channel is to be used, turn the CHANNEL switch to the second position and repeat the above for this channel.

(e) Tuning of the r-f coils to a new frequency on actual signals is a simple matter for the 1.7 to 2.075 mc. channels, provided the signals on the desired channel are strong enough to "spill over" on the original channel. When tuning to a new channel on actual signals, make a time difference reading and check that the channel is tuned to the correct signals by comparing this reading with a known location.

(2) ALIGNMENT OF R-F STAGE, USING A SIGNAL GENERATOR.

Channels No. 1 and No. 2 of the Receiver have a tuning range of 1.70 mc. to 2.075 mc. Channels No. 3 and No. 4 have a tuning range of 9.9 mc. to 12.1 mc. (before installation of the coil kit). The i-f is aligned at 1100 kc. Should it be desirable to realign the Receiver or align it to a new radio frequency, the following procedure is recommended:

(a) Obtain a signal generator capable of producing the desired frequency and select the channel (with the CHANNEL switch) within which it falls. (See the Tuning Range Table under Electrical Specifications.)

(b) Set the Receiver GAIN control to the point where a small amount of noise appears on the trace.

(c) Connect the signal generator to the antenna jack.

(d) Tune the signal generator to the frequency at which the channel was formerly tuned, using the highest percentage modulation of the highest modulation frequency available. (400 cycles at 30% will be satisfactory if nothing better is available.) Tune the coils the same as on actual signals. *ALTERNATE:* to use a signal generator without modulation, connect a vacuum tube voltmeter across the diode load resistance, R417, and tune for maximum voltage output, or, if a vacuum tube voltmeter is not available turn the BALANCE control to one side and use the distortion at the left edges of the traces (on SWEEP SPEED 1) as an indication of the tuning, tuning for maximum distortion. Turning the BALANCE control to one side produces a square-wave modulation of the C.W. signal which causes the distortion of the leading edges of the traces.

(e) Start with a signal of 1000 microvolts and reduce its value as the receiver is tuned. The receiver video FILTER switch should be "OUT".

(f) Slightly move the signal generator setting in the direction of the desired new radio frequency.

(g) Adjust the OSC stud for a maximum signal amplitude. Repeat for the CONV. and ANT. studs.

(h) It is suggested that the signal generator be advanced in the desired direction in small increments until the new r-f frequency is reached, and that the three peaking adjustments be made after each change in signal generator frequency. After some experience with the Receiver, the operator may make this alignment in one step. It must be remembered the Receiver is a pulse receiver and is likely to overload and block on a continuous-carrier signal. It may therefore be possible, if too large a signal is applied, to pass by the desired signal without noticing it, or to arrive at an incorrect peak.

(i) The output of the signal generator should finally be reduced to a few microvolts, the receiver gain turned up to produce about 1/2 inch of noise on the scope, and the studs should be adjusted separately for maximum signal response, in the sequence of OSC., CONV., and ANT.

(j) The antenna input circuit of the receiver is designed for 50 ohms, but in actual practice the impedance of the antenna used will seldom be this value. Therefore, final tuning of the antenna input circuit should always be made in accordance with the instructions under Maintenance alignment of the antenna loading coil unit. When measuring sensitivity, however, a standardized value can be obtained by using a signal generator with a 50 ohm output impedance, or by inserting series resistance to make the impedance 50 ohms. The reading in microvolts on the signal generator will then be twice the number of microvolts applied to the receiver.

(k) The average selectivity curve for all bands of the Receiver is given in Fig. 5-1. It should be noted from this curve that the band-width is greater than 75 kc. at two times down (6 db) but less than 250 kc. at 100 times down (40 db). Although the curve shows a bandwidth of greater than 75 kc. at 2 times down (6 db), 50 kc. is sufficient.

(3) ALIGNMENT OF THE I-F SYSTEM.

This alignment should be made only when it is *absolutely necessary.*

(a) The intermediate frequency amplifier utilizes four overcoupled i-f transformers in order to give the desired bandwidth. To adjust these to an optimum, a sweep-type of signal generator is needed which will produce a sweep approximately 300 kc. wide, starting at 950 kc. and ending at 1250 kc. An oscilloscope is also necessary for this alignment.

(b) The oscilloscope should be connected to the end of L400, which is inside the diode filter box. The metal cover shield over the receiver and also the filter box cover must be removed in order to reach the lead from this coil.

(c) The oscilloscope sweep speed should be synchronized with the sweep rate and the gain should be increased until a downward-projecting curve is obtained.

(d) Connect the sweep signal generator to the grid of the third i-f stage, V405, pin No. 4. Note that this grid is above ground potential, in respect to d-c, and will require a series isolating condenser of about .01 mfd.

(e) The curve should appear in the middle of the base line, provided the sweep covers an equal range of frequency on either side of 1100 kc. The curve should appear to have a flat bottom and be rather steep on the sides. (Note—In order to see the true i-f curve, it is necessary to move the three wave traps, tuned to i-f, to some other frequency. It is suggested that the first two—L401 and L402—be moved to a lower frequency by turning their studs full in. These traps are located behind the front panel and their adjustment studs are available from the left side. The third trap, L403, located in line with L401 and L402, should be tuned to a higher frequency by screwing its stud all the way out.)

(f) Adjust the sweep generator output to give a fair signal on the oscilloscope and adjust i-f transformer

T404, to give a flat bottom on the curve (Fig. 5-2). Keep the curve symmetrical about the center.

(g) Now connect the sweep generator to the grid of V404, pin No. 4. Decrease the input voltage and align T403 (Fig. 5-2).

(h) Move to the grid of V403, pin No. 4, and adjust T402 (Fig. 5-2).

(i) Next move to the grid of V402, pin No. 8, and adjust T401 (Fig. 5-2).

(j) A flat-bottomed curve with steep sides should now be seen on the oscilloscope. A large rise in the middle of the curve indicates misalignment in one or more of the stages.

(4) EMERGENCY ALIGNMENT OF I-F SYSTEM.

In cases of emergency where time is an important factor or when complete test equipment is not available, the following alignment procedure may be followed. This method does not give a perfect alignment and should be avoided where possible.

(a) On the underside of the Receiver tube chassis between the i-f tube sockets, find the small terminal boards, each of which has a terminal marked A1, A2, or A3. If these terminals are shorted to ground, separately by means of short leads, the overcoupling of the i-f transformers is removed and it is then possible to align the i-f system with an ordinary signal generator having the 400-cycle modulation as described in the r-f adjustment section. A ground terminal is provided adjacent to each of the above terminals to make grounding easy. The removal of the overcoupling, however, changes the tuning of the i-f transformers and consequently it becomes necessary to align these transformers at 1065 kc. instead of 1100 kc. (see Fig. 5-4). If 400 cycle modulation is used on the signal generator, the cathode ray tube on the Indicator Unit can be used as an amplitude indicating device. When the shorts are removed, the i-f tuning will shift to the proper frequency and the i-f alignment will be fairly good. Remember to keep the signal input voltage down to a minimum to avoid overloading or blocking the Receiver.

(b) If no equipment is available, the i-f can be peaked on air signals with the SWEEP SPEED switch on No. 4 position. Particular attention should be paid to keeping the pulse shape good while tuning for maximum amplitude.

(c) It is normally possible to eliminate bothersome signals on the i-f frequency which appear as sine waves or spots of noise at regular intervals along the base line of the slow sweep by turning the FILTER switch to "IN".

(d) The FILTER switch alters the video response of the Receiver in such a manner that when the switch is "OUT" the low frequency response is good down to 1000 cycles per second. When the switch is "IN", the low frequency response is only good down to 10,000 cycles, which makes it possible to remove low frequency interference such as C.W., I.C.W., and noise crashes. The filter "IN" will flatten the base line under conditions where considerable differential gain is being used and the base line is torn up.

(5) ALIGNMENT OF WAVE TRAPS, USING A SIGNAL GENERATOR (PREFERRED METHOD).

Before tuning the wave traps, check them, and if they are close to the proper frequencies do not retune them.

(a) Connect a signal generator to the antenna input-jack, adding enough series resistance to give the generator a 50-ohm terminal impedance. Turn the RECEIVER switch to ON, SWEEP SPEED to "1", and modulate the signal with 400 cycles (or more). *ALTERNATE.* Use an unmodulated signal and connect a vacuum tube voltmeter across the diode load R417.

(b) Using a strong signal from the generator at 1060 kc, turn L401, the first trap behind the panel, to give maximum rejection to this frequency. The maximum rejection will appear as minimum output on the cathode ray tube screen (or minimum voltage on the vacuum tube voltmeter), therefore increase the signal as much as is necessary for accurate results.

(c) Using a signal of 1100 kc. from the generator, adjust the second trap, L402, to give minimum output from the Receiver.

(d) Using a signal of 1145 kc. from the generator, adjust the third trap, L403, for minimum output from the Receiver.

(e) When the wave traps are tuned to any frequencies other than those specified above, oscillation may occur when maximum gain is used.

(6) ALIGNMENT OF WAVE TRAPS USING A SWEEP-SIGNAL GENERATOR.

(a) Connect the sweep signal generator to the antenna input jack, and connect an oscilloscope as in *Alignment of the I-F System.* Considerable input will be necessary at 1100 ± 150 kc.

(b) Turn the adjustment screw of the first trap behind the panel, L401, in a counterclockwise direction until its effect is seen on the i-f curve as shown on the oscilloscope. Assuming the center frequency to be 1100 kc, move the wave trap curve into the i-f curve about 1/3 of the way, or to approximately 40 kc. on the lower frequency side of the center.

c. Turn the stud of L403 clockwise until this wave trap curve appears on the right margin of the i-f curve. Then move this curve about 1/3 of the way in, but slightly less than the L401 curve, to about 45 kc. on the other side of the center. (This is predicated upon the use of an oscilloscope trace whose low frequency end is on the left and whose high frequency end is on the right.)

d. By turning its stud counterclockwise, move the second trap L402 until it puts a dent into the middle of the i-f curve.

e. Check for oscillation in the Receiver by turning the GAIN control all of the way up. If oscillation occurs, reset the trap slightly to stop it.

e. RECEIVER SENSITIVITY AND BANDWIDTH CHECKS.

The following methods for checking the sensitivity

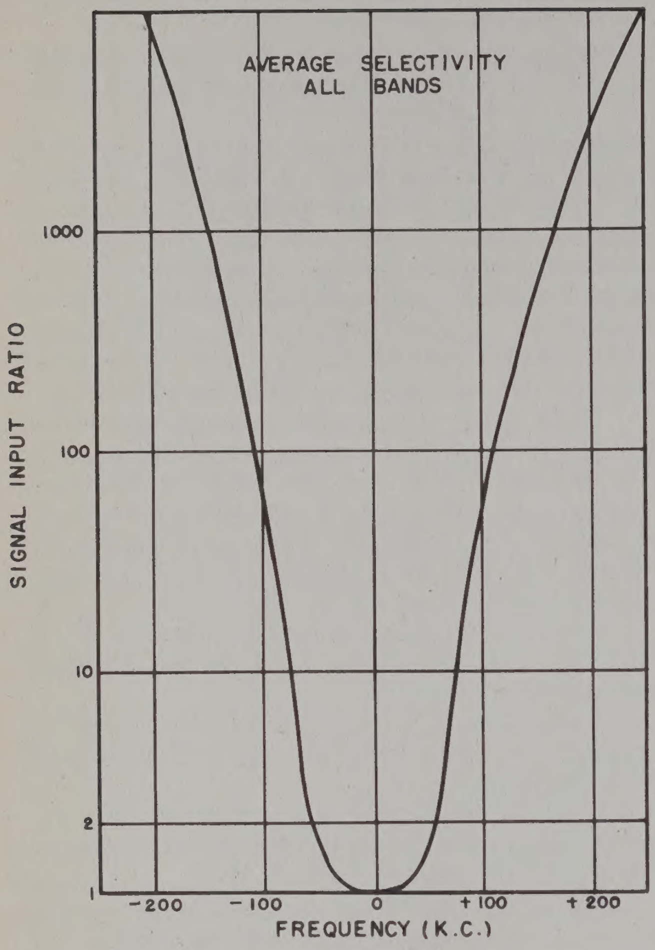


Figure 5-1—Receiver Selectivity Average Curve

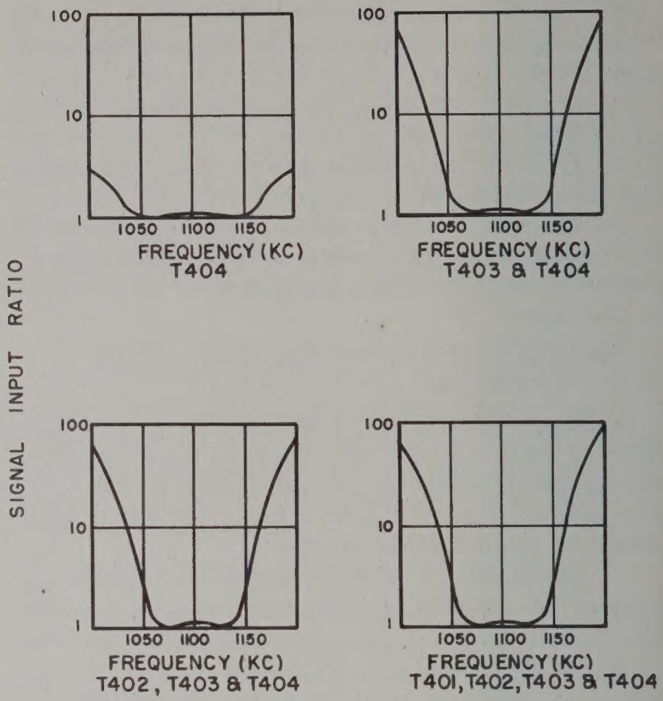


Figure 5-2—I-F Stage Alignment Curves

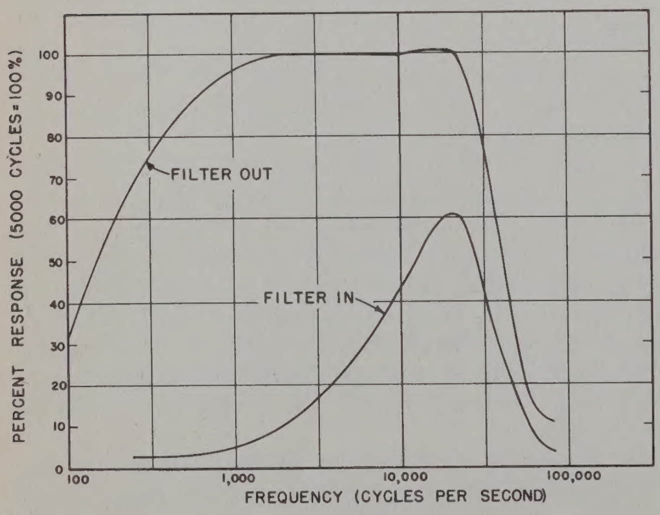


Figure 5-3—Video Response Curve

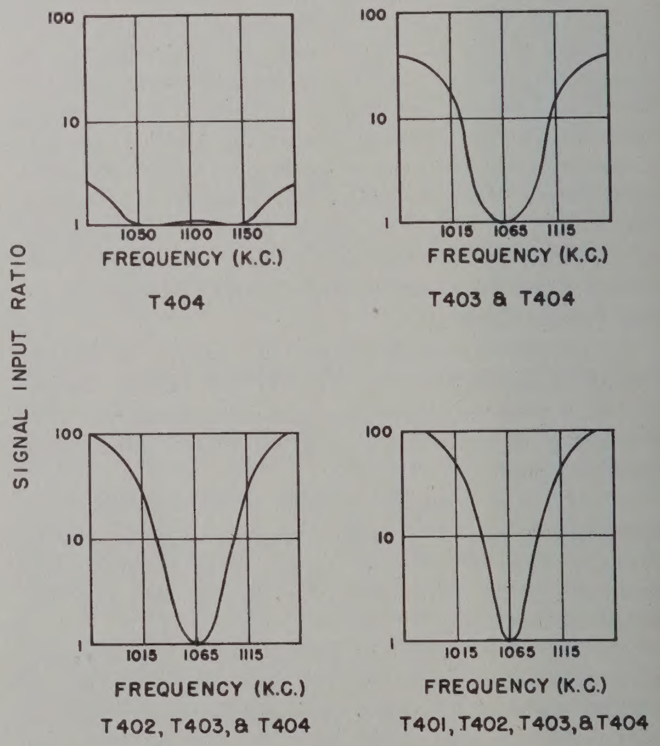


Figure 5-4—Emergency I-F Stage Alignment Curves

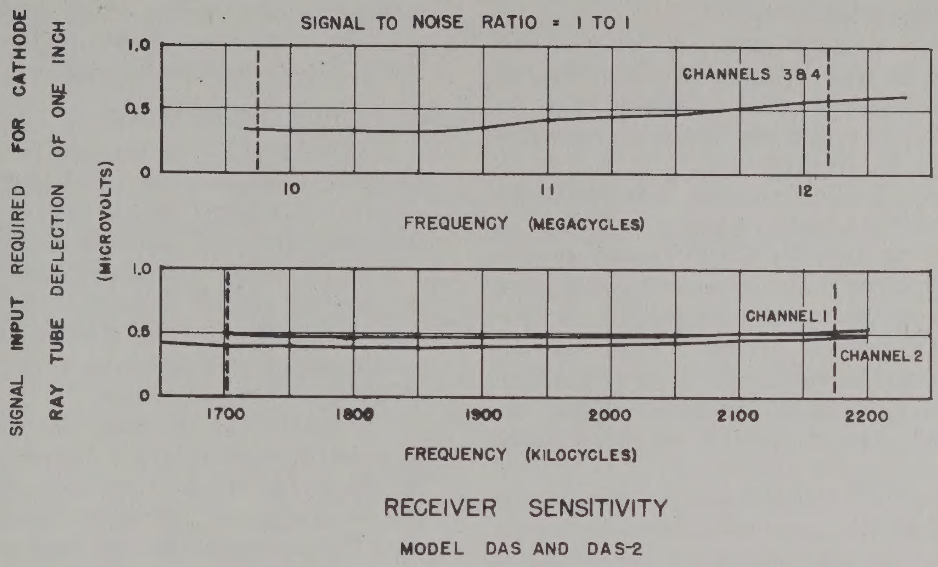


Figure 5-5—Receiver Sensitivity Curves

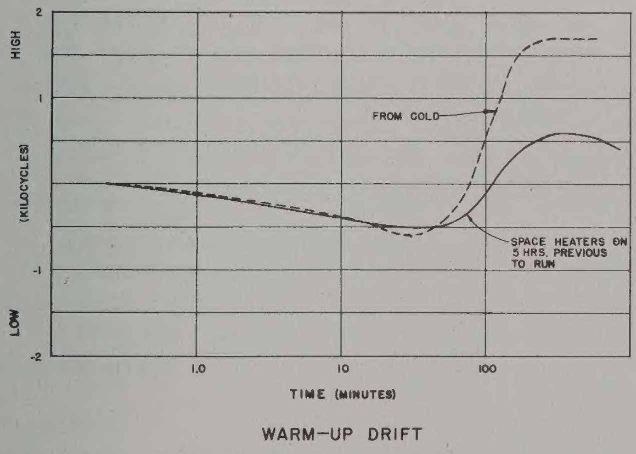


Figure 5-6—Receiver Drift Curves, Channels One and Two

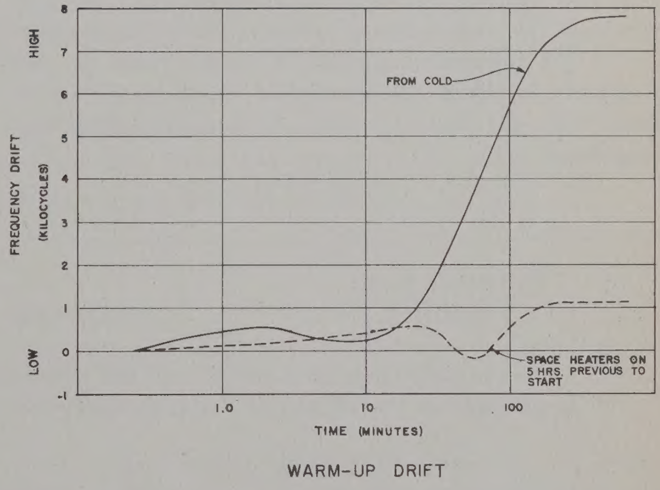


Figure 5-7—Receiver Drift Curves, Channels Three and Four

and bandwidth of the Receiver are extremely simple, yet afford a good estimate of the Receiver alignment.

(1) RECEIVER BANDWIDTH.

(*a*) Connect a signal generator with an unmodulated output between the antenna plug, J401, on the front panel and ground. The antenna input is designed for a 50-ohm input and the output impedance of the Generator must be matched to it.

(*b*) Connect a D-C vacuum tube voltmeter across the diode load impedance, L400.

(*c*) Adjust the Receiver GAIN control to give a one volt output across L400 when the signal input *to the antenna connection* is 10 microvolts at the frequency to which the channel is tuned. (Ten microvolts at the antenna connection will not be ten microvolts at the signal generator unless the generator output impedance is 50 ohms and no external matching circuit is required.)

(*d*) Double the voltage input to the antenna connection and shift the generator frequency first in one direction and then the other, until the output of the Receiver returns to one volt. The difference between the two frequency readings is the bandwidth at two times down (6 db.), and should fall between 50 and 100 kc.

(*e*) Increase the voltage input to the antenna connection to 100 times the original value, and again shift the generator frequency in both directions until one volt of output from the receiver is obtained. The bandwidth in this case is at 100 times down (40 db.) and must be less than 250 kc. (Avoid arriving at an incorrect point due to overloading at the Receiver.)

(2) RECEIVER SENSITIVITY.

(*a*) Secure a signal generator capable of producing 30% modulation at 400 cycles. Connect the generator between the antenna plug J401 and ground, matching the impedances as when checking bandwidth.

(*b*) Impress a signal of 3 microvolts at the frequency to which the channel is tuned (30% modulated with 400 cycles) across the antenna connection to ground.

(*c*) Turn the Receiver GAIN toward maximum and receiver filter out, and watch the Indicator unit cathode ray tube for signs of the modulated signal. If the modulation becomes clearly visible through the noise, the Receiver is sufficiently sensitive.

4. TROUBLE SHOOTING

a. GENERAL.—The majority of troubles which will arise in the equipment can be corrected by a simple maintenance alignment. When alignment fails to correct the faulty operation, more serious trouble has developed and the following table is provided for that eventuality. As may be noticed from studying the table, vacuum tubes cause the greatest number of failures and it is recommended they be replaced in a circuit before attempting any major repairs.

The table lists, in order, the *Evidence of Trouble* as it will be noticed on the cathode ray tube, the circuit or component which is the most *Probable Cause,* and last the *Suggested Corrective Measures* to be tried. It must be understood that the table makes no attempt to anticipate all of the troubles which may arise nor to list all of the measures which may be necessary to correct for a given trouble. It does, however, serve as an excellent guide to the circuit in which some defect will cause the particular trouble.

WARNING

WHEN CHANGING 6H6 TUBES IN THE EQUIPMENT, ALWAYS USE A GLASS TUBE IN SOCKET X122. A METAL TUBE IN THIS SOCKET WILL OPERATE WITH THE SHELL AT HIGH VOLTAGE (1600 VOLTS).

Note

In most applications, except as noted above, metal and glass 6H6 tubes may be interchanged. Another exception is that there is insufficient clearance above sockets X107 and X127 for some makes of glass tubes, and they cannot be used.

b. TROUBLE SHOOTING CHART.

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
1. 115 v. a-c input circuit shorted or grounded but fuse does not fail	Line filter condensers shorted Mechanical short	Check C309 and C310 Check for L301, L302, L303, L304 short to filter cover
2. Equipment generally unstable	Power Supply failure	If plus 300 varies more than a volt or so with turning of Receiver GAIN Control, investigate regulator failure. Check Power Supply tubes, particularly Rectifier V301. Check line voltage, if low (below 112 v.) set Voltage Control R308 to give 280 v. output instead of 300 and realign counters: check Heater Voltage on tubes in in-

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
2. (Continued)		dicator and ascertain that back terminal board connections on Power Supply are good
3. No trace or spot on SWEEP SPEED 1 (make sure spot is not just off screen by turning horizontal and vertical centering controls)	Anode connection off cathode ray tube	Replace connector
	No primary voltage	Check a.c. line voltage and fuses
	Open filament on cathode ray tube	Measure V129 filament resistance and filament transformer resistance
	No high voltage	Check: H.V. rectifier tubes V306, V307, R210 (H.V. Filter); H.V. Transformer T302
4. No traces, but round spot shows on SWEEP SPEED 1 with Receiver OFF or ON, or spot traveling, across screen at very slow rate	Failure in + 300 v Power Supply circuits (only if no spot movement)	Check Power Supply for short between + 300 v and ground; burned out fuse; replace rectifier tube V301; regulator tubes V303, V302, V304, V305
	Failure in Crystal Oscillator or Buffer circuits	Replace V101, V102 Check L102 and C106 (oscillator may be super-regenerating or blocking) Check L101 for shorted turns (good coil should have a Q of approximately 40, shorted turn Q is less than 5) Check R101 for continuity
5. No traces, but spot shows on SWEEP SPEED 1 with Receiver ON, small upward pointing tail (10 microsecond markers) shows when Receiver OFF. (Oscillator and 10 microsecond marker circuits operating.) Round dot only when Receiver on CAL 1 or CAL 2	Failure in First Counter circuit	Replace V102, V103; check for dirt or short in C119
6. No traces, but round spot with downward projecting tail (50 microsecond markers) show on SWEEP SPEED 1. (First and Second counter circuits are operating.) Same pattern on Receiver CAL 1 or CAL 2	Failure in Second Counter circuits	Replace V104, V105; check for short or dirt in C119

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
7. No traces, but spot with two downward projecting tails (50 and 500 microsecond markers) shows SWEEP SPEED 1 with Receiver ON, same with Receiver on CAL 2, vertical row of ten dots and tails on CAL 1. (2nd Counter and marker circuits operating)	Failure in 3rd Counter circuits	Replace V105, V106
8. No traces, but round spot with three downward projecting tails (50, 500 and 2500 microsecond markers) shown on SWEEP SPEED 1 with receiver ON, vertical row of ten dots and tails on CAL 1, vertical row of 5 dots and tails on CAL 2. (3rd counter and marker circuits operating)	Failure in 4th Counter circuit Failure in Time Corrector circuit	Replace V107, V108 See item 9 below
9. Same as 8 above, plus erratic fast sweep (SWEEP SPEEDS 2 to 5) which show change in pattern as station switch is turned. (4th Counter operating)	Failure in Time Corrector E.J. circuits, or in 500 microsecond amplifier circuits	Check adjustment of R143 (Time Corrector adjustment) replace V108, V109, V110, V116 Check output capacitors C132, C133, C134 for shorts Check C132, C133, C134, R140, R141, R134, and R135 for tolerances, as circuit may be unbalanced If serial number of equipment is 105 or less, check that Change No. 2 has been made and that the Time Corrector grid circuits are in accordance with the schematic diagram. This change makes the Time Corrector adjustment less critical.
10. No traces, but two round dots with tails, one dot above the other, show when Receiver is ON. (Trace separation indicates square wave generator is operating)	Failure in sweep circuits	Replace V123, V124
11. No Trace separation or pedestals on fast sweeps (or action erratic)	Eccles-Jorden circuit not functioning	Adjust Time Corrector (R143) and Eccles-Jorden cathode (R148); Replace V109, V111. (Unbalanced tubes may cause faulty operation) Check plate and grid resistors for tolerance. (Check also R151 and R156)
12. SWEEP SPEED 1 correct but fast sweeps blurred and bright	Insufficient blanking Leaky blanking condenser	Replace V122 Check C193

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
13. No pedestals but trace separation correct on SWEEP SPEED 1	Failure of Pedestal Generator or 10 Microsecond, Receiver, Pedestal Mixer	Replace V128, V144
	Minimum delay controls set too low	Increase minimum delay time R333 and R337
14. Only an upper pedestal	Failure of Fine or Coarse Delay or Gate	Replace V119, V126, V127
	Minimum delay controls set too low	Increase minimum delay by R337 and R333
15. Lower pedestal only	Failure of Fixed Delay or Gate	Replace V120, V121
16. Cathode ray tube trace weak, poor focus	Defective or weak cathode ray tube	Change tube V129
	No positive high voltage	Check rectifier tube V307
17. No effect from the INTENSITY control adjustment	Defective Blanking Restorer tube	Replace V122
	Leaky coupling condenser	Check C193
	Insufficient blanking voltage	Replace V123
	Grid-to-cathode leakage in cathode ray tube	Replace tube
18. VERT. CENT. control has insufficient range; centering varies	Leaky coupling capacitors	Check C202, C149 for leakage or short
19. HOR. CENT. control has insufficient range, traces cannot be centered horizontally	Defective tube in sweep circuits	Change V125, V124
	Control potentiometer defective	Check R252
20. Trace short and off center on all sweeps	Sweep Amplifier failure	Replace V125
21. Trace off center on SWEEP SPEED 1	Sweep Generator failure	Replace V124
	Pedestal Buffer failure	Replace V123
22. Sweep lengths too long or short on all sweeps	Defective tube in sweep circuits	Replace V124, V125
	Off tolerance resistor in sweep circuits	Check R246, R247, R248, R250, R251, R242
	Wrong Power Supply voltage	Check primary power line voltage
23. Trace too long or short on Fast Sweeps	Defective Pedestal tube	Replace V128, V127, V121
	Broken or Shorted Trimmer	Check C177
	Off-value resistance	Check R275, R269 and R272

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
24. Upper trace flutters on SWEEP SPEED 1	Defective trace separation	Replace V117, Trace Shift Mixer
	If serial number is 105 or less, Change No. 2 should be made	See Maintenance section Instructions for Making Equipment Modifications, page 5-22
25. Excessive horizontal "jitter" in lower trace on fast sweeps	Defective Fine Delay tube	Replace V126
	Coarse Delay not well synchronized on 500 microsecond markers	Replace V116, V119
	60 cycle voltage causing uneven triggering of Fine Delay	Check grounding between Indicator and Power Unit. Check V126 Heater circuit for a ground
26. Horizontal jitter on slow sweep	Use of 6SK7 tube with straight heater wire in socket X124	Replace with another make of 6SK7 tube or any make of 6SJ7
27. Excessive "hum" on traces with Receiver GAIN set at minimum	Failure of Power Supply regulator	Replace V302, V303, V304, V305. Check C303A and C305 for open circuits
28. Pedestal height low	Pedestal Mixer partial failure	Replace V114
29. Pedestals and Markers are not at right angles to trace, and pulses are loops on slow trace	Stray coupling between vertical and horizontal cathode ray tube plates	Dress leads going to cathode ray tube pins 7 and 8 apart from leads to pins 10 and 11
	Deflection plates in cathode ray tube are not at right angles due to shocks received	Replace the cathode ray tube
30. Multiple Pedestals on Slow Sweep or multiple crossing traces on Fast Sweep	Multiple firing of Pedestal Generator	Incorrect setting of Pedestal length control, R277
	Multiple firing of Coarse and Fine Delay	Too high a setting on minimun delay controls R333, R337
	Multiple firing of Fixed Delay	Incorrect setting of Fixed Delay control R202
	General multiple firing	Change tubes V128, V126, V119, V123, V127, V121
	Capacity pick-up of leads	Dress Lead from V123 Pin #1 to R235 so as to introduce capacity to ground around fixed delay control R202
	Open ground connection	Check all ground connections in Delay circuits by measuring voltage or resistance
31. Fixed Delay does not synchronize on first 2500 microsecond marker; top pedestal in wrong location	No 2500 microsecond signal to the delay circuit	Replace V116

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
32. Coarse Delay is too great or does not advance the lower pedestal in steps of 500 microseconds	No 500 microsecond signal from amplifier	Replace V116
33. Lower trace time delay varies intermittently, pedestal "jumps"	Leaky grid capacitor in Delay Circuits	Check C147B and C170B for leakage
34. Crystal will not tune to correct frequency	L103 open. L101 cut-off adjustment	Replace L103. Adjust L101
	L101 open	Replace L101
	Crystal defective	Replace Y101
	Oscillator plate circuit not tuned	Check L102 and C106
35. Only 10 Microsecond Markers and Pedestal, or other markers unevenly spaced (one counter is running free)	Failure in Marker circuit	Replace V117
	Leakage or short in counter grid circuit	Replace counter and gate tube. Check for leakage or short
	Open storage condenser	Check C116, C120, C123, C127
	Open or shorted damping resistor on blocking oscillator transformer	Check damping resistors
	Open blocking oscillator transformer	Check transformer resistance
36. No 10 Microsecond Markers but other markers normal	Failure of 10 Microsecond Marker Generator	Replace V101
37. All markers present but too small or large	Failure in Marker circuit	Replace V117
	Counter tubes weak	Change counter tubes
38. Small 10 Microsecond Markers but other markers normal	Crystal not oscillating	Replace V101; Check crystal Y101; Check V101 and V102
39. 10 Microsecond Markers too large and poor shape	Insufficient bias on V101-2	Check C112 and R106 for a short or low resistance
	Insufficient damping on L104	Check R105
40. No effect from the 10 Microsecond Phase Shift adjustment R103	L103 adjusted incorrectly	Readjust L103
	R103 defective	Check resistance of R103
41. Counter range insufficient when adjusting C1, C2, C3, or C4. (C4A, C4B)	Defective tube	Change tube of counter which is defective, also check tube of previous counter
	Off tolerance resistors	Check values of counter cathode resistors and bleeder resistors from + B
		If "C 4" or "C4A" has insufficient range on L PRR, see Change No. 7, Page 5-28

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
42. Second or Third Counter steps slope, Counter is unstable	Leakage to counter grid circuits. If steps slope up, leakage is to +300; if steps slope down, leakage is to ground	Change both counter and gate tube in offending stage. Check leakage of grid storage capacitors and coupling capacitor (leakages of the order of 100 megohms are important)
43. No Display on CAL. 1 or CAL. 2	Defective Test Circuit, cathode follower	Replace V115
44. CAL. 1 position shows less than 10 steps but unit functions otherwise. (On SWEEP SPEED 3, ten 50 microsecond intervals show between 500 microsecond markers)	Time Corrector not functioning properly	Adjust Time Corrector to give 10 steps on CAL. 1
45. Only a single spot on the cathode ray tube for one pos. of STATION selector switch	Feedback capacitor shorted	Check C151, C152, C154, C156, C158, C160, C162, for shorts
46. STATION Selector setup trimmers have insufficient range	Defective Gate tube	Replace V118
	C119 set at too high or too low capacity	Readjust C119
	Second or Fourth Counters defective	Replace V105; V108
47. Receiver dead or weak	Defective tubes in Receiver	Change tubes
	Shorted by-pass capacitor	Check C403, C408, C414, C420, C445, C443
	Open diode filter	Check L400
	Open Gain Control	Check R214
	Open or shorted i-f transformer	Check T401, T402, T403, T404, primary and secondary for continuity
	Local Oscillator not functioning	Check V402, pin 5, with analyzer. Should show negative voltage. Check C440, C441, C432, C442 for open or short
	Open Video Amplifier Screen By-Pass	Check C443
48. No signals or noise with Receiver GAIN at maximum. Receiver otherwise normal	Receiver blocking	Check for strong, blocking carrier from nearby transmitter

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
49. Signals weak, but a high noise level	Antenna and r-f stages not tuned	Check tuning of Loading-Coil and r-f tuning coils
	Antenna circuit open	Check antenna lead-in and connector for open or short
	Defective tube	Replace V407, V406
	Open coupling capacitor or peaking choke in output	Check C437, L404
50. Receiver oscillates; extremely high noise level	Misalignment of the Receiver	Some Receivers may oscillate without the antenna and coaxial lead connected, but work normally when loaded with the antenna Realign wave traps properly. Change tubes if necessary
	Open by-pass capacitor	Check by-pass capacitors C403, C408, C414, C420, C445
51. Transients in video, poor high frequency response	Video coupling capacitor case grounded	Check insulation of C437 case to ground
52. No effect from the FILTER switch	Defective switch	Adjust or replace
53. Receiver GAIN control has no effect	Heater-to-cathode short in receiver tube	Replace V401, V402, V403, V404
54. Pulse distorted on fast sweeps	Receiver Oscillator or r-f stages misaligned	Check alignment of Receiver
	I-F bandwidth too narrow	Check C412, C418, and C423 for short circuits
	Receiver switched to wrong channel and signal "spilling over" from another channel	Turn CHANNEL switch to see if signals come in clear and undistorted on another channel
55. Pulse will not stay put on fast trace	Crystal not oscillating; or missing	Replace crystal Y101. Check L102 and C106
	Counter chain miscounting	Check counter alignment NOTE: If the First and Second Counters are just on the edge of correct adjustment but skipping occasionally, the test patterns may look correct and not show skipping
56. Very wide crystal tuning range	Plate not tuned Crystal not oscillating	C169 shorted. Replace Y101

EVIDENCE OF TROUBLE	PROBABLE CAUSE	SUGGESTED CORRECTIVE MEASURES
57. Frequency does not change as FREQUENCY control is turned, and dial does not turn	Vernier drive slipping	Adjust planetary drive
58. Pulse rapidly jumps across the screen when using LEFT-RIGHT switch	Leakage into grid circuit of First Counter	Check C196 and C197 for leakage
59. No BALANCE Gain action	Defective Balance or Balance Gain Control tube	Replace V112, V113, V405
60. Insufficient BALANCE Gain action.	Defective Receiver tube. Incorrect grid voltage on V405.	Replace V405. Check Grid Voltage V405, pin 4.

c. RESISTANCE AND VOLTAGE MEASUREMENTS.—If the defect in the equipment cannot be readily located from the above chart, turn to the pictorial diagrams of tube socket resistance, voltage, and current, Figs. 7-21 to 7-24, and make a complete check on the equipment. The diagrams should be used in conjunction with the unit Schematic Diagrams, Figs. 7-25 to 7-27. Always check resistance values first and avoid measuring voltage values if possible because of the hazard involved.

5. MAINTENANCE METHODS

a. INSPECTION POSITION. — It is possible to make all routine checks and adjustments to the Receiver-Indicator, except the Time Corrector and E.-J. BIAS, by simply drawing the two unit chassis out of the cabinet about 2/3 of the way, to the inspection position as shown in Fig. 1-3. The five knurled thumbscrews across the top and the five across the bottom of the front panels are all that hold the center strip and chassis in place. Beware of HIGH VOLTAGE (2200 volts) present in the Indicator and Power Supply units. No interlocks are provided in this equipment.

b. CATHODE RAY TUBE REPLACEMENT.—The cathode ray tube must be inserted and removed through the front panel. Four thumbscrews hold the light shield to the panel. As soon as these screws are removed the light shield, lens, and rubber gasket all come free from in front of the tube shield. The tube then may be pushed in or pulled out of its socket. Remember the HV plug must be disconnected from the side of the tube before the tube is removed. The socket is held firmly to the vertical chassis and adjusted by four knurled nuts, two on each side of the socket. HANDLE CATHODE RAY TUBES WITH EXTREME CAUTION, WEAR GLOVES AND GOGGLES.

c. POTENTIOMETER AND POT. LOCKS REPLACEMENT.—All potentiometers inside the unit are screwdriver adjusted and provided with locking mechanisms. These locks should be tightened enough to prevent free turning of the shaft and still allow adjustment. The potentiometers are mounted on the chassis by inserting the potentiometer shaft in a hole and then securing it with a nut which fits over the shaft and the threaded bushing. The locks are also held in place on the bushing by the same nut. All potentiometers on the Indicator Unit are easily accessible for replacement. The six delay potentiometers (COARSE DELAY, FINE DELAY, and the two pair of HI and LO controls) on the Power Supply Unit front panel, however, are mounted on a bracket which must be freed from the panel before the potentiometers can be removed. The bracket is held by three screws through the front panel, one between and one directly above each of the DELAY control knobs. The two Allen setscrews in each knob must also be loosened and the knobs removed to completely free the potentiometer assembly from the panel.

d. FRONT PANEL REMOVAL.—The front panels are held in place by the screws around their periphery and by the pull-out handles. Screws whch pass through the upright section of the chassis, the panel, and into each end of the two handles must first be removed and the handles pulled free. Then, when the screws around the edges of the panel are taken out, the panel can be removed.

e. RECEIVER CHASSIS DISASSEMBLY.—The receiver chassis is held firmly to the Power Supply by four screws, and the two units appear to be one (Fig. 1-4). When the screws, which are at the four corners of the Receiver bottom plate, are removed the two units may be separated. It is best to disconnect the interconnecting wires at the Receiver Unit and not at the Power Supply Terminal Board.

f. RECEIVER SHIELD REMOVAL.—The Receiver shield covers all of the Receiver components except the tubes, i-f transformers and wavetraps. The shield is held in place by six screws, one at each corner of the top, and one at each of the lower corners of the side. The leads to the space heater also must be disconnected when removing the shield. (Remember that turning the power switch "OFF" energizes the space heaters and if the leads hang free they are likely to be shorted. Remove the power connector before disassembling.)

g. RECEIVER TUNING-COIL BOX REMOVAL.—The receiver tuning-coil box is mounted on the Receiver chassis by four screws from the underside. To remove the box the Receiver must be demounted from the Power Supply and the bottom plate and the Receiver shield removed. One of the screws which holds the bottom plate also holds one corner of the Coil Box. Three additional screws, passed through from the underside of the chassis, hold the other three corners of the box.

The connections from the Coil Box are all above the chassis, and should be removed not at the Coil Box but at the tubes and capacitors where they terminate. The CHANNEL knob on the front panel also holds the Coil Box in place. Remove the connections, knob, and screws in order, then pull the Coil Box free.

The tuning coils are fastened to the top of the Coil Box. Once the box has been removed from the chassis, access to the coils is obtained by removing the bottom cover of the box. This cover is held in place by five screws on two sides of the box. Remove the screws and pull off the bottom cover, exposng the coils and switches.

h. BOTTOM COVER PLATES REMOVAL. — The bottom plates on the Power Supply and Indicator Units are held in place by screws through the front end of the plate and into the chassis just behind the front panel, and by screws through the rear of the chassis and into an upright bend of the plate. In the Power Supply there are four screws at the front and three across the rear; in the Indicator there are two screws at the front and three across the rear.

The bottom plate of the Receiver is held in place by two screws through the lower corners of the front panel and four screws through the plate and into the underside of the chassis. The plate is made up of three parts, one large plate and two smaller cross pieces.

i. POWER LINE FILTER REMOVAL.—The power line filter is located behind the front panel of the Power Supply, just above the main chassis. To remove the filter for repairs or replacement, first remove the four screws which pass through the front panel, two on either side of the Model nameplate, into the four corners of the filter box. This frees the box except for the four wire connections.

Remove the three screws through the side of the chassis holding the power receptacle cover behind the front panel. Then remove the two screws holding the cover to the top of the chassis and remove the cover. Unsolder the two connections to the power receptacle that are exposed when the cover is removed. Unsolder at the fuse holder the lead to it from the filter, and unsolder from the front panel (ON-OFF) switch the remaining filter lead. The filter assembly can then be pulled free. (If necessary, remove the delay potentiometer bracket from the back of the front panel to obtain more clearance for removing the filter box.)

j. RECEIVER FILTER BOX COVER REMOVAL.—The video filter is located behind the Receiver tube chassis, under the cover shield. When the Receiver shield is removed, the Filter Box is exposed. To gain access to the filter, remove its cover by first removing the four nuts on the side facing the rear of the chassis. When these four nuts have been removed, the cover may be pulled off, exposing the components.

6. INSTRUCTIONS FOR MAKING EQUIPMENT MODIFICATIONS.

The following Instructions cover methods for making the changes, Change No. 1 through Change No. 7, listed on page 1-4. For most of the changes, kits containing parts and circuit components are necessary and must be obtained before the change can be made.

a. CHANGE NO 1.—STATION SWITCH TRIMMERS.

On the first five Model DAS Equipments, the seven set-up trimmer condensers for the STATION switch were originally located on the rear of the vertical chassis. This made removal of the Indicator Chassis from the case necessary before the trimmers could be adjusted. On the other Model DAS units and on the Model DAS-2 the trimmers are mounted on a bracket in front of the vertical chassis, beneath the cathode ray tube where they may be adjusted when the Indicator Unit is in the inspection position.

A *Loran Shipboard Modification Kit* is supplied for each of the first five Model DAS units, serial numbers one through five, with components and instructions for relocating the trimmers in front of the vertical chassis. The kit contains seven air trimmers mounted on a bracket, a terminal board wired to the trimmers, a terminal insulation strip, and accessories for installation. To add the kit components proceed as follows:

(1) Completely withdraw the Indicator Unit from the case.

(2) Remove the two screws which fasten the bracket, holding the STATION SELECTOR switch and the seven trimmers to the main chassis at the rear of the vertical chassis.

(3) In the station switch coupling, loosen the Allen screws which are nearest to the switch.

(4) Remove the nut and lockwasher holding the switch to the vertical chassis and bracket. Save this nut and lockwasher for use in reassembling.

(5) Unsolder the two leads to the switch wafer and the one lead to the common terminal (extreme upper left) of the terminal board which mounts on the STATION SELECTOR switch. Note the terminals from which these leads have been removed and tag them, because these connections will have to be re-made.

(6) Withdraw the station switch assembly from the rear of the Indicator Unit.

(7) Unsolder the connections between the seven trimmers and the terminal board at the terminal board. This terminal board is mounted on the rear of the station switch.

(8) Discard the metal bracket including the trimmers. Handle the switch and the terminal board assembly with care. Avoid damaging the ceramic capacitors mounted on the board.

(9) Remove the new trimmer bracket assembly, terminal board, and terminal strip from the wooden shipping base.

(10) Looking at the front of the vertical chassis, remove the upper right-hand screw and the two lower screws which hold terminal board TB106 to the back of the vertical chassis.

(11) Mount the new trimmer bracket assembly on the front of the vertical chassis with the V cut in the plate uppermost and the plate flat against the vertical chassis below the cathode-ray tube shield.

(12) Using two screws and two lockwashers removed from TB106, push the screws through the trimmer mounting plate, through the chassis and screw them into the two lower tapped holes in the brackets on TB106. Use the #4 screws, lockwashers, and nuts supplied to fasten the upper corners of the trimmer bracket to the vertical chassis. No new holes need to be drilled, but the ends of all screws should be covered with Glyptol, or similar paint. The terminal board TB106 should now have only three screws holding it to the vertical chassis.

(13) Fasten the terminal strip and the terminal board which is already wired to the trimmers to the vertical chassis over the opening to the immediate right of the trimmer assembly (looking at the front of the vertical chassis). The terminal board and strip are mounted to the chassis by means of two #6 screws, lockwashers and nuts supplied. The terminal board is spaced from the chassis by means of two 1/8″ Textolite spacers which fit on the #6 screws. The terminal strip fits flush against the rear of the vertical chassis.

The terminal board should be mounted so that the printed numbers are visible from the front of the vertical chassis and can be read from the nearest side of the Indicator.

The terminal strip should be mounted so that the printed numbers are visible from the rear of the vertical chassis and are opposite the corresponding numbers on the terminal board.

(14) Solder the two leads to the corresponding terminals of the switch wafer from which they were previously removed.

Also solder the lead which was removed from the common terminal (extreme upper left) of the STATION SELECTOR switch terminal board back to this terminal.

(15) Reassemble, by means of nuts and lockwasher, the switch and terminal board assembly to the vertical chassis.

(16) Push the switch rotor into the station switch coupling from which it was previously removed and tighten the Allen screw.

Make sure that when the STATION SELECTOR knob points to zero, the switch is all the way to the left.

(17) With the bus wire supplied, make the following connections from the STATION SELECTOR switch terminal board to the trimmer assembly terminal board through the corresponding holes in the terminal strip, covering each bus with the insulation supplied.

(*a*) Solder a bus from the right-hand terminal of C157 on the switch terminal board to solder lug 4 on the trimmer assembly terminal board.

(*b*) Solder a bus from the upper terminal of C163 on the switch terminal board to solder lug 7 on the trimmer assembly terminal board.

(*c*) Solder a bus from the upper terminal of C161 on the switch terminal board to solder lug 6 on the trimmer assembly terminal board.

(*d*) Solder a bus from the upper terminal of C159 on the switch terminal board to solder lug 5 on the trimmer assembly terminal board.

(*e*) Solder a bus from the upper right terminal of C155 on the switch terminal board to solder lug 3 on the trimmer assembly terminal board.

(*f*) Solder a bus from the upper-right terminal of C153 on the switch terminal board to solder lug 2 on the trimmer assembly terminal board.

(*g*) Solder a bus from the extreme lower right-hand terminal on the switch terminal board to solder lug 1 on the trimmer assembly terminal board.

(*h*) Solder a bus from the extreme upper left-hand terminal on the switch terminal board to solder lug COMMON on the trimmer assembly terminal board.

(18) Check the connections made as follows:

(*a*) With a suitable ohmmeter, measure the resistance between the end terminals of the eight bus wires just connected. In each case, the ohmmeter should read infinite ohms.

(*b*) Measure the resistance between all possible pairs of solder lugs on the trimmer terminal board. When its pointer comes to rest, the meter should read infinity.

(*c*) Measure the resistance between each solder lug on the trimmer terminal board and the chassis. All readings should be infinity.

b. CHANGE NO. 2.—REMOVE TIME CORRECTOR GRID RESISTORS.

The adjustment of the Time Corrector circuit on the Model DAS units, serial numbers 1 through 106, was too critical, limiting the range of the cathode bias resistor R143. After serial number 106 this situation was remedied in units before they left the factory. No kit is required for modifying the first 106 units to make them like later units, simply proceed as directed below.

(1) Remove the Indicator Unit from the cabinet and place it, upside down, on a table or on the cabinet. Remove the shield, or bottom plate, from the chassis.

(2) Facing the front panel, remove the fourth resistor from the rear on the extreme left-hand terminal board, TB101. This resistor is R134, 150,000 ohms.

(3) Remove the resistor R135, 100,000 ohms, from the terminal board TB105, across the rear of the right-hand half of the chassis.

(4) From the same rear terminal board TB105, remove R137 and put it in the space on TB101 where R134 was removed. This is a 91,000-ohm resistor

(5) From the same terminal board TB105, remove resistor R142 and put it in the space where R135 was removed from TB105.

(6) Remove the markings R137 and R142 from terminal board TB105.

c. CHANGE NO. 3.—IMPROVE FOCUS OF CATHODE RAY TUBE AND ADD A PRR SWITCH.

The following two modifications must be made in all Model DAS equipments, and they then become Models DAS-a. After this, and the foregoing changes have been made the Model DAS units become identical to the Model DAS-2 units. The *Rate Change and Cathode Ray Adapter Kit* is required for making the changes.

(1) CATHODE RAY TUBE FOCUS.

Early in the production of the DAS Equipments it was found that a large percentage of the Dumont 5CP1 Cathode Ray Tubes would not focus well in the equipment because of lack of range in the Astigmatism Control. Tests indicated that a range of approximately 450 volts was required for these tubes, while manufacturers' recommendations specified a total range of only 100 volts. Tubes of RCA and National Union manufacturer, however, performed well in the equipments, within the specified range. These last two tube makes have an extra element in the electron gun that the Dumont tubes lack.

A few DAS Equipments were shipped with Dumont tubes in them and in the spares, but the majority have RCA, 5CP1 cathode ray tubes. Perfect focus is not obtainable with the Dumont tubes, although the display is perfectly usable. This kit contains components of a new circuit which will correct the focus for all tubes.

The wide range of control required for Dumont tubes was found to be due to the difference in the mean potentials between the horizontal and the vertical deflection plates. The difference in these mean potentials was approximately 100 volts. By reducing this difference to a small amount, not more than 20 to 30 volts, the Astigmatism Control range is made ample. When the parts from this kit have been installed, the required small value will be obtained.

(*a*) Remove the center panel from the front of the cabinet and withdraw the Indicator Unit.

(*b*) Facing the front panel of the Indicator, lay the unit on the left side and remove the textolite shield which will then be on top, (if necessary). This shield is half-way back on the frame, and is held in place by three screws. On it is written: DANGER HIGH VOLTAGE. This shield is very hard to replace, so if steps (*c*) and (*d*) can be done without removing it, omit this step.

(*c*) On the bottom side of the top terminal board, now exposed, locate R215 and unsolder its connections. The resistor may be discarded.

(*d*) Where R215 was removed, replace it with the 330,000-ohm resistor from the kit, and solder in place.

(*e*) Cut a piece of insulated wire about 24 inches long and solder one end of it to the terminal which is common to both R215 and R216. Run the other end along the edge of the frame toward the back, and through the rubber grommet in the vertical chassis (the grommet is in the upper right-hand corner of the chassis, facing it from the front).

(*f*) Replace the textolite shield if it was removed.

(*g*) Turn the indicator around so as to face the rear, and notice two holes in the rear deck, two inches apart and just to the left of the center, under the Station Selector switch. Put the terminal board assembly from the kit over these holes, and hold in place so that the numbers can be read from the rear.

(*h*) Drop the two binding head screws from the kit through the holes in the terminal board and through the matching holes in the rear deck. Secure them on the underside of the chassis with the lock washers and hex nuts provided.

(*i*) Run the wire installed in step (*e*) down the left side of the vertical chassis (facing from the rear), along the junction of the rear deck and vertical chassis, and bring it out to the right-hand side of the new terminal board.

(*j*) Cut off the excess wire, and solder the end of the lead to the terminal at the right-hand end of R162.

(*k*) Solder a piece of bus wire between the terminals on the left-hand side of the terminal board.

(*l*) On the outermost wafer of the RECEIVER switch, S102B, locate the wire which goes directly to the socket of the cathode ray tube, pin No. 7, and unsolder it from the switch. This wire may be located by looking at the switch from the rear of the unit. Starting at the bottom of the switch it is the first terminal in a counterclockwise direction. The fingers from this terminal make contact with the band on the switch rotor.

(*m*) Cut a piece of insulated wire about eight inches long, and solder one end to the switch terminal where the wire was removed in step (*l*).

(*n*) Run this wire down to the rear deck, across behind the new terminal board and out to the terminal at the right-hand side of C202. Cut off the excess wire and solder the end to the terminal.

(*o*) Splice an insulated wire about six inches long to the end of the wire which was just removed from S102B (step *l*). Run the free end down to the rear deck, and across it to the left-hand side of the new terminal board. Solder the end to either of the terminals which were connected together in step (*k*).

(*p*) The unit is now ready for operation, and may be returned to the cabinet. If all connections have been made properly, the focus should be improved for all Dumont tubes. Readjust the ASTIGMATISM control, simultaneously varying the FOCUS control, and obtain the clearest possible trace.

(2) ADDITION OF THE PRR SWITCH.

The Model DAS-2 Navigation Equipments have provisions incorporated which provide for a sweep repetition rate on the oscilloscope of 66 2/3 per second, as well as the standard 50 c.p.s. second. This makes it possible to receive pulses at a base repetition rate of 33 1/3 pulses per second, as well as a rate of 25 pulses per second. The number of permissible stations operating on any one radio frequency is thereby doubled.

The Model DAS Navigation Equipments cannot receive the signals at the 33 1/3 pulses per second rate until the changes described below are made. The change involves the addition to the Indicator Unit circuit of a potentiometer (R186) and a switch (S105). Both of these additions are in the cathode circuit of the tube V108-1 of the Fourth Counter, and provide an alternate connection between the cathode bias resistor R282 and ground. Both the new switch and new potentiometer are mounted on the front panel of the Indicator Unit. In addition, the vertical and horizontal centering potentiometers are removed from this panel. Caution must be used not to damage these potentiometers, however, because they must be mounted on a new bracket behind and to the left of the panel, as shown in Fig. 7-9, and used again.

To make the installation and changes outlined above:

(*a*) Remove the Indicator Unit from the cabinet. This is done by first loosening the two knurled screws on the center cover and removing it, then loosening the four ¾″ knurled screws at the top and bottom of the indicator panel. Now, using the handle, draw the unit out until it catches. Press in on the spring catch on the left side of the chassis, draw the unit the rest of the way out of the case, and place it on a bench or on top of the case.

(*b*) Locate the mounting bracket from the kit on the side of the Indicator, as shown in Fig. 7-9, and using the bracket as a template drill three holes with a No. 23 drill. Countersink the holes to receive No. 6 flat head screws.

(*c*) Remove the horizontal centering potentiometer from behind the upper-left-hand corner of the front panel. This potentiometer is mounted on a bracket and held in place by a nut and lock washer. The nut is on the side of the bracket toward the front panel, and must be removed to free the potentiometer. Insert this potentiometer in the new mounting bracket from the "Kit" in such a way that when the bracket is screwed to the frame the potentiometer will be in the upper hole and the shaft and screwdriver adjustment will face outward. Slip a potentiometer lock from the "Kit" over the shaft and then replace the lockwasher and nut.

(*d*) Remove the vertical control potentiometer from behind the upper right-hand corner of the front panel of the Indicator Unit. This potentiometer is secured in the same way as the other one. Place it in the other large hole in the bracket, and make sure that this screwdriver adjustment will also face toward the outside. It wll be necessary to splice in 10-inch sections of wire to extend the connections to the other side of the unit. Secure the potentiometer with the lockwasher, nut, and "Pot Lock", and then fasten the bracket to the frame of the indicator. The bracket should be on the inside of the frame and held in place by the three #6 screws found in the "Kit".

(*e*) The bracket behind the upper left-hand corner of the front panel, which formerly held the horizontal centering control, is no longer needed. Remove the two screws holding this bracket to the frame and discard it.

(*f*) The hole at the upper left of the front panel, which originally accommodated the horizontal control, must be enlarged for the new toggle switch from the kit. Enlarge this hole to 31/64-inch diameter with a drill. Insert the switch in this hole, pushing it through from the back of the panel, and hold in a horizontal position. Select the nameplate from the "Kit" that has "PRR" across the top and slip this over the switch on the front side of the panel. Secure the assembly with one of the lockwashers and nuts provided for the purpose. Be sure the switch is in a horizontal position and the nameplate is right-side up before tightening the nut.

(*g*) The remaining nameplate, marked "C4B", is to go over the hole at the upper right-hand corner of the front panel where the vertical control potentiometer was removed. This nameplate is to be held in place with two screws. Using the nameplate as a template, drill and tap two holes and attach the nameplate with the two small screws from the "Kit".

(*h*) Insert the new potentiometer in the upper-right hand corner of the front panel. The potentiometer will fit into the bracket that formerly held the vertical centering control, so mount it just as that potentiometer was mounted and secure it with the remaining lockwasher and nut.

(*i*) Turn the unit up on end so that it rests on the back frame members and remove the screws holding the bottom plate. There are five of these screws, two in front and three in back. Remove the plate, making the underside of the chassis accessible. Disconnect the wire from the cathode resistor R282 that connects with potentiometer R132 (marked C4 on the front panel). The other wire from the other end of R282 may easily be traced to pin #3 of tube V108-1, and this wire is to be left in place. The resistor R282 is between the seventh pair of terminals, counting from the back of the chassis, on the right side terminal board (TB101).

Withdraw the disconnected end of the wire until it is free of the chassis. Now thread the free end of the wire across the underside of the chassis from R132 through the opening in the center partition in back of the gain control, to the grommet in the front left corner. Run the wire up through the grommet and up the front left frame member beside the cabled wire to the top, outside terminal of the new toggle switch.

(*j*) Connect a wire about 36 inches long to the top center terminal of the toggle switch and run it down the frame member and through the same grommet mentioned above. Thread this wire across the unit, behind the front panel, then down the right side by terminal board TB101 to R282. Solder the end of this lead to R282 where the other connection was initially removed.

(*k*) With a wire about nine inches long connect the inside top terminal of the toggle switch to the outside terminal of the new potentiometer.

(*l*) Cut a piece of wire at least 20 inches long and connect one end of it to the other terminals of the new potentiometer. Run the other end of the wire down the front left frame member, beside the wire just brought up to the outside terminal of the toggle switch. Run it beside that wire through the grommet and back to R132. Notice a short length (about one inch) of uninsulated wire is connected from R132 to the metal support for the condenser C102. Solder the end of this new wire to the same point on the support for C102 to which the uninsulated wire is soldered.

(*m*) Slide the Indicator Unit back into the case and turn on the power. Snap the "PRR" switch to "L", the SWEEP SPEED switch to No. 1, and the RECEIVER switch to CAL. If the unit was previously in adjustment, you should now have eight groups of five steps on each oscilloscope trace. If there are not eight groups, readjust "C4". Next snap the "PRR" switch to "H" and adjust the new potentiometer "C4B" to give six groups of five steps each.

d. CHANGE NO. 4.—REMOVE INDICATOR FILAMENT GROUND.

The filament supply in Model DAS and Model DAS-2 equipments, serial numbers 1 through 375, is grounded in both the Receiver and Indicator Units. This allows a part of the large filament current to return to the power supply through the common ground connection, causing a slight 60 cycle ripple voltage to exist between the units. The voltage creates a fluctuation of the Balance Gain Control at a 60 cycle rate which produces a flutter on the top of the received pulse. The Indicator Unit filament ground connection must be removed to prevent the flutter.

(1) Remove the Indicator Unit from the cabinet and turn it upside down on a table or on top of the cabinet. Remove the bottom cover plate.

(2) Locate socket X104 on the underside of the main chassis. This socket is about midway to the back of the left half of the chassis, as you face the front panel.

(3) Pins No. 1, 2, and 3 of the socket are connected together, and pin No. 3 or pin No. 1 is connected to ground with bus wire. Unsolder the bus wire at pin No. 2, and pull it free of the pin. One filament lead is connected to each of the three pins. Unsolder the leads connected to pins No. 1 and 3, and solder them to pin No. 2. The ground connection to pin No. 3 (or pin No. 1) must not be broken.

e. CHANGE NO. 5.—BALANCE GAIN CONTROL.

The Model DAS and DAS-2 equipments are capable of balancing received signals, one of which is not greater than forty times as strong as the other. This requires reducing the Receiver gain during the period of time that the strong signal is being received. Quite frequently the ship carrying the equipment is much closer to one transmitter than it is to the other, however, and one signal is more than forty times as strong as the other. The equipments, serial numbers 1 through 407, cannot balance the received signals under these conditions, and so the Balance Gain Control and Balance Control circuits must be modified. The *DAS Control Modification Kit* is required for this change.

(1) Remove the Indicator Unit from the chassis, and place it upside down on a table, or on top of the cabinet. Remove the bottom plate, or shield.

(2) Locate socket X113 on the underside of the chassis which is now exposed. This socket is the fourth one toward the back on the right-hand side as you look at the chassis from the front panel.

(3) An insulated lead terminates on pin No. 6 of X113, and pin No. 6 is tied to pin No. 1 with a short length of bus wire. Unsolder and remove the ends of the bus and the lead from pin No. 6.

(4) Pins No. 4 and No. 5 are connected together and to ground. Remove all of this wiring, including the ground wire.

(5) Solder the ends of the bus and the lead removed from pin No. 6 to pin No. 4.

(6) Connect pin No. 2 to pin No. 5 with a piece of insulated wire from the kit.

(7) Connect pin No. 3 to pin No. 6 with a piece of insulated wire from the kit. The two halves of tube V113 are now connected in parallel.

(8) In about the middle of the terminal board nearest to X113 (TB104), locate R165. The uppermost end of this 6200-ohm resistor is connected to a group of other resistors, and also to ground. The lower end is connected to pin No. 3 of socket X113. Remove the resistor.

(9) On the rear terminal board, TB105, there is no R137, but there is a place marked for it. Scratch off the numbers.

(10) From the kit, secure the two 4700 ohm, ±5%, 1 watt resistors.

(11) Insert one of the 4700-ohm resistors between the R165 terminals, and the other between the unused terminals next to the R165 terminals. Connect these resistors in parallel, and label the unmarked one R137.

(12) The fifth and sixth resistors toward the front panel from R165, and also on TB104, are R241 and R260. Remove both of these resistors. They were in the grid circuits of the two halves of tube V112.

The cathodes of V112-1 and 2 will now operate at 180 volts peak. The filament of the tube is at ground. This high potential difference may possibly cause excessive failures of the tube. If you do have failures, it will be necessary to interchange the filament connections for V112 and V119, but if the failures do not occur, the change is unnecessary on units already in service.

(13) To interchange the filament connections of V112 and V119, first locate socket X112 and remove the two filament leads from each of pins No. 7 and 8. Looking at the underside of the chassis from the front panel, the socket is the third toward the back on your right-hand side.

(14) Next, locate socket X119 and its filament leads connected to pins No. 7 and 8. This socket is the first one on the right side, still looking from the front of the unit.

(15) Unsolder the two filament leads, one from each of pins No. 7 and 8 of X119, and solder these free ends of the leads, to pins No. 7 and 8 of socket X112.

(16) Two leads were removed from each pin of socket X112, and in each case the ends of the two were soldered together. Solder a third lead, about six inches long, to each of these junctions and tape the joints.

(17) Run the two new leads along the chassis to socket X119, and connect one to each of pins No. 7 and No. 8. The filaments of V112 and V119 are now interchanged.

To reduce distortion of strong signals in the Receiver Unit, the two 6SG7 tubes, V403 and V405, must be replaced by 6SK7 tubes, and the suppressor grids grounded. A resistor must also be changed.

(18) Remove the Receiver and Power Supply Units from the cabinet and place, right-side up, on a table or on top of the cabinet.

(19) Remove the shield, or cover, from the Receiver. This shield is held in place by screws at the four corners on top, and two screws on your right-hand side as you face the front panel. The two leads to the space heater, also on your right-hand side, must be disconnected.

(20) On the socket for tube V403, between pin No. 5, pin No. 3 and C414A, is a length of bus wire. Unsolder this wire from pin No. 3 and pull it free. Then solder a short length of wire between pin No. 3 and pin No. 1.

(21) On the socket for tube V404 a bus wire connects pin No. 5, pin No. 3, and capacitor C420-A. Free this bus from pin No. 3 also, and connect a short piece of wire between pin No. 3 and pin No. 1.

(22) On the terminal board between V403 and V404 locate R408, 68 ohms. Remove this resistor and replace it with the 270 ohm ±5%, ½ watt resistor from the kit.

(23) Pin No. 5 is connected to pin No. 3 on the socket of tube V405. From pin No. 3 one shielded lead runs through a grommet in the bottom of the chassis and one is connected to the by-pass condenser, C425. Disconnect the shielded leads and the jumper from pin No. 3, and connect the loose ends of the three together.

(24) The shields on the cables are grounded to a post coming up from the bottom of the chassis. Connect a short wire between this post and pin No. 3 of socket X405.

(25) Remove tubes V403 and V405, 6SG7 tubes, from their sockets. Now replace them with the two 6SK7 tubes taken from the kit.

(26) Replace the metal shield, or cover, and reconnect the two leads to the space heater.

(27) Replace the Receiver and Power Supply Unit in the cabinet.

f. CHANGE NO. 6.—CONTROL POTENTIOMETERS.

Two potentiometers and a knob must be replaced in all Model DAS and DAS-2 units with serial numbers, 1 through 580, and a ground connection removed. The *DAS Control Modification Kit* contains the parts necessary for the changes.

When the filament ground connection was removed in the Indicator Unit, a jitter was introduced in the Fine Delay circuit through the filament transformer, T105. This may be eliminated by removing the center tap ground of the transformer.

(1) Remove the Indicator Unit from the cabinet and place it upside down on a table or on top of the cabinet. Remove the metal shield or bottom plate.

(2) Locate T105, in the rear right-hand corner, looking at the bottom of the chassis from the front panel. One yellow lead from this transformer is con-

nected to pin No. 6 of the socket X126. This socket is just to the outside and below the transformer.

(3) Unsolder the transformer lead from the socket pin, and cover the end of it with insulating tape.

The control range of the Main Gain Control knob is concentrated in a small portion of the total range. A tapered potentiometer is used for this control, one-half of which is 500 ohms and the other half is 1500 ohms. With the present potentiometer the control operates, generally, in a small portion of the 1500-ohm half. The new potentiometer reverses the taper so that operation will be mainly in the 500-ohm half, and a larger portion will be used. The knob, with the new potentiometer, will have to be turned through three times the angle previously turned through, for the same amount of charge in the gain of the Receiver.

(4) Turn the Indicator Unit upon end, resting it on the back frame members. Just behind the front panel, and under the main chassis, locate the two counter-potentiometers, those marked C2 and C4 (or C4-A) on the front panel. These are R120 and R132.

(5) Remove the locking nut that holds the potentiometer on your left (C2 or R120) in place, and slide it out of the hole in the chassis.

(6) Loosen the locking nut holding the potentiometer on your right. Between the two potentiometers is a short (3 inches) section of frame to which the bottom plate was screwed. This may now be rotated about the right end, making the Main Gain potentiometer accessible.

(7) With the Allen wrench supplied on the side of the Power Supply, loosen the two Allen screws on the side of the Main Gain Control knob. Remove the knob.

(8) Remove the locking nut which holds the Main Gain potentiometer, R214, in place, and slide the potentiometer out of the chassis. There is a track cut in the chassis for sliding this potentiometer out.

(9) Unsolder and remove all wires from this Main Gain potentometer, noticing carefully from which terminals the leads are taken.

(10) Take the new 2000-ohm potentiometer from the kit, and slide it into place where the old one was removed. Replace and tighten the lock nut and washer, holding the potentiometer in such a position that the terminals face in the direction they did with the original one.

(11) Resolder the wires to the potentiometer terminals corresponding to those from which they were removed.

(12) Rotate the frame member back into position, and replace the C2 potentiometer, R120. Replace and tighten the lock nut and washer, and tighten the lock nut on C4 (or C4-A) R132.

(13) Replace the control knob, and tighten the Allen screws.

(14) Replace the bottom plate and return the Indicator Unit to the cabinet.

The fine Delay Control, located on the Power Supply front panel, is a wire-wound potentiometer. A much finer and more even control can be obtained from a carbon potentiometer. The carbon replacement is in the kit, and should be installed as follows:

(15) Draw the Power Supply and Receiver Unit out of the cabinet until it strikes on the safety catch.

(16) With the Allen wrench provided on the side of the chassis, loosen the two Allen screws holding the Fine Delay control knob, and remove it. This knob may be discarded.

(17) Just behind the front panel is a second panel with six potentiometers mounted on it. This second panel is held in place by three screws from the front panel. Remove the three screws, one from between, and one from above each of the two Delay Controls.

(18) Remove the Coarse Delay Control knob, and save it. The potentiometer mounting panel is now free, and may be pushed back away from the front panel.

(19) Remove the locking nut holding the Fine Delay potentiometer to this mounting panel, and slide the potentiometer out.

(20) Unsolder the connections to the potentiometer, being careful to note from which terminal each lead is removed.

(21) Take the 10,000 carbon potentiometer from the kit, and insert it in the mounting panel where the other potentiometer was just removed. Replace and solder the connections as they were before.

(22) In the kit is a drilling plan, P42J967, for the front panel of the unit. Drill and tap two holes below the Fine Delay control knob as shown on the drawing. Use a No. 36 drill and a No. 6-32 tap.

(23) Remove two of the fillister head screws, two lockwashers, and two nuts from the kit. First put the screws in the holes just drilled, then on the backside of the panel put on the nuts and lockwashers. They will serve to lock the screws in place. The screws should not protrude beyond the nuts, or they will be in the way of the mounting panel.

(24) Slide the mounting panel back into place and secure it with the three screws through the front panel.

(25) Take the knob and remaining screw from the kit. On the underside of the knob, where it will fit against the panel, there is a tapped hole. Insert the screw in the hole. The combination of screws on the panel and on the knob serve as a stop to protect the potentiometer.

(26) Put the new knob on the Fine Delay control, and before tightening the Allen screws be sure the knob is properly centered to give full range on the potentiometer. Replace the Coarse Delay knob and be sure it too is properly centered.

g. CHANGE NO. 7.—FOURTH COUNTER CATHODE RESISTOR.

Fourth Counter cathode bias determines the sweep repetition rate of the Indicator Unit. In the Model DAS the cathode resistor (R132) covers a range which is sufficient to allow a sweep repetition rate of either 50 or 66 2/3 per second. The addition of the PRR switch and its circuits to the Models DAS-a and DAS-2 eliminates the necessity for adjusting one resistor to both rates and allows modification of the cathode circuit to give more stable operation.

The added PRR circuit contains the cathode resistor R186 which gives cathode bias to the counter for operation at the 66 2/3 sweeps per second rate, with ample range on each side. The original circuit (R132) is then used for the 50 sweeps per second rate exclusively, and in some cases it is necessary to center the adjustable range on this rate to give ample coverage. A resistor (R285) is added between potentiometer R132 and the PRR switch for this purpose, as shown on the schematic diagram, Fig. 7-27.

Only units above serial number 771 have the added resistor when the units are received in the field. To add the resistor to other units, proceed as follows:

(1) Locate the pair of unused terminals marked R162 on terminal board TB103. (This terminal board is on the underside of the Indicator Unit chassis (Fig. 7-16) and the terminals are those nearest to the front panel).

(2) Scratch off the marking R162 and replace it with R285, then insert a 3900 ohm ±5%, 1 watt resistor between the terminals. (This resistor is contained in the spare parts for the equipment and is the same as R190).

(3) Locate R132, the C4 (or C4A) control potentiometer. One side of the potentiometer is connected to ground and the other side, by means of an insulated lead, to the PRR switch. Unsolder the insulated lead from the potentiometer, cut it to just reach the new resistor R285, and connect to one terminal of the resistor.

(4) Cut an insulated lead about six inches long and connect it between the other terminal of R285 and the lug on R132 from which the first lead was removed. The C4 (or C4A) control will now adjust the counter for the 50 sweep per second rate with ample range on both sides of 50.

7. PERFORMANCE STANDARDS

a. VACUUM TUBE DATA, as measured on a commercial tube checker, is not necessarily an indication of the value of tubes in these applications.

(1) Operating voltages and essential tube currents are given on the pictorial diagrams, Figs. 7-21 to 7-24. All of the tubes used in the Models DAS and DAS-2 are included as standard items in current commercial tube catalogs.

(2) Tubes should be discarded whenever they are found to cause improper or poor operation of this equipment. ALL TUBES OF A GIVEN TYPE SUPPLIED WITH THE EQUIPMENT SHALL BE CONSUMED PRIOR TO EMPLOYMENT OF TUBES FROM GENERAL STOCK.

b. NORMAL PERFORMANCE CHARACTERISTICS are outlined, with typical cathode ray tube patterns, in the OPERATION section of this book under the heading of *Operating Alignment Check.* In addition, Receiver characteristic curves are shown in Figs. 5-1 to 5-7 and normal operating voltages at all tube sockets are given in Figs. 7-21 to 7-24. The output voltage wave from each component circuit is shown on the Block Diagram of the Receiver-Indicator, Fig. 7-20.

c. TERMINAL RESISTANCES between all external terminals and between all tube socket pins and ground are included on the pictorial diagrams, Figs. 7-21 to 7-24.

8. TECHNICAL INFORMATION

a. INDICATOR UNIT CRYSTAL DATA.—The Indicator Unit Crystal (Y101) oscillates at 100 kc at 35°C, and over the range from zero to +80°C the frequency does not change by more than —150 nor +100 parts per million.

When the crystal is placed in parallel with a shunt-tuned circuit (as used in Models DAS and DAS-2), which is resonated to 100 kc, a change in tuning capacity of 50 mmf. will vary the crystal frequency by plus and minus 300 parts per million.

The front panel FREQUENCY control on the Indicator is a 50 mmf. air trimmer in series with a 100 mmf. ceramic capacitor. Turning the dial through its range varies the crystal oscillator frequency by a minimum of ±200 parts per million.

The LEFT-RIGHT control on the Indicator switches additional shunt capacitors in and out of the circuit, producing a change in the frequency of approximately 80 parts per million.

Dimensions of the crystal holder and pin connections to the crystal are given on Fig. 5-17.

b. CERAMIC INSULATORS which may be replaced as a unit are shown on Fig. 5-16. Should it be necessary to replace the insulators when no spares are available, the items should be made to these dimensions.

c. WINDING DATA for all wirewound components of Model DAS or Model DAS-2, except resistors, is included in this book. This data is in the form of specifications on drawings, Fig. 5-10 to 5-15.

d. COLOR CODE OF WIRE.—Material shortages at the time of production necessitated numerous substitutions in the colors of the wire used. The following color code therefore has not been followed in all cases.

When tracing circuits the color code may be helpful, but should not be depended upon completely.

Wire Color	Connections in Circuits
Red	+B voltage
Red-White	+B voltage
Orange	Screen wiring and intermediate +B
Blue	Plate wiring
Green	Grid wiring
Brown	Cathode leads
Black	Ground connections
White-Black	—F (ground side of heaters)
White-Red	+F (high side of heaters)
White	Miscellaneous circuits
Black-White	Miscellaneous circuits
Blue-Heavy	—HV circuits
Red-Heavy	+HV circuits
Green-Heavy	CRT filament

e. RESISTOR COLOR CODE

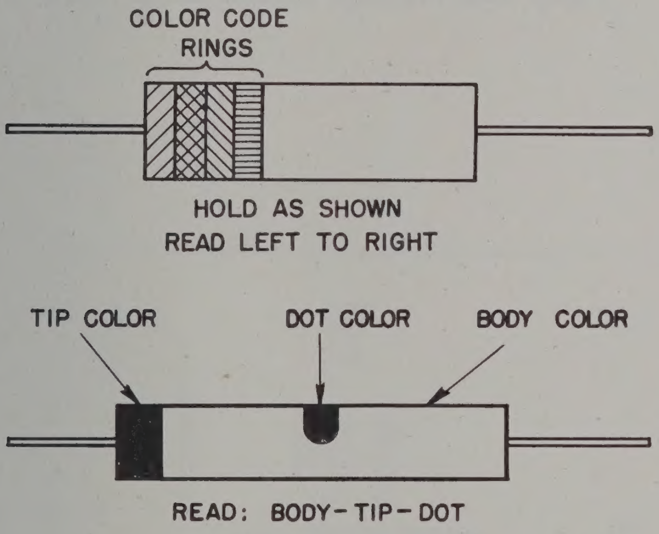


Figure 5-8—Resistor Color Markings

First significant figure—First band on left, or body color.

Second significant figure—Second band from left, or tip color.

Multiplier—Third band or dot color.

Tolerance—Fourth band or "Unused" end color.

The corresponding colors and figures are as follows:

1—Brown
2—Red
3—Orange
4—Yellow
5—Green
6—Blue
7—Violet
8—Gray
9—White
10—Black

The tolerance colors are:

Gold	5%
Silver	10%
No color	20%

When reading the resistor values, read the first two significant figures and add a number of zeros equivalent to the third figure. Examples—If the four rings are (in order) green, black, red, and silver, the resistor is 5,000 ohms with a 10% tolerance. A resistor with black, yellow and violet bands is 04.7 ohms with a 20% tolerance.

f. CAPACITOR COLOR CODE

(1) RMA STANDARDS.

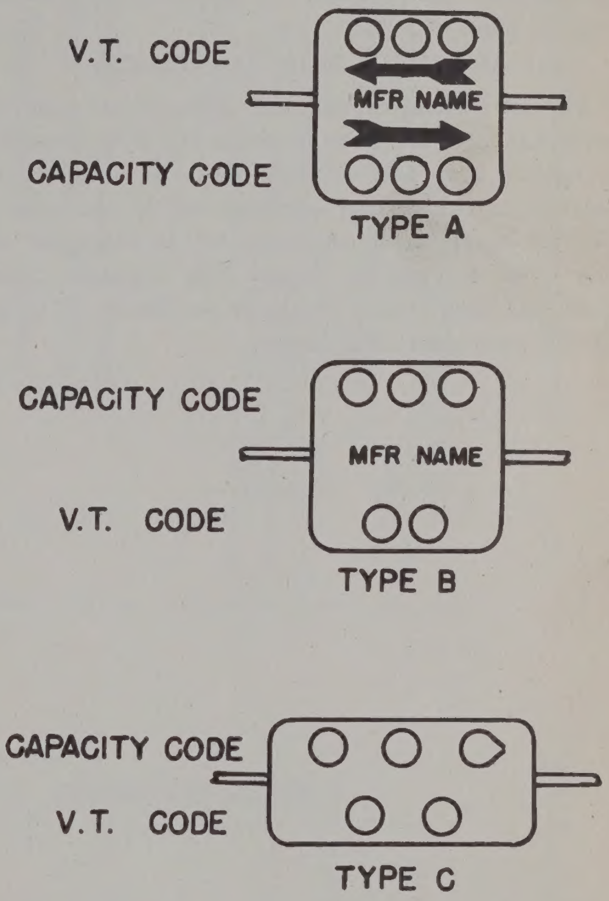


Figure 5-9A—Capacitor Color Markings (RMA)

(*a*) When the capacitors are held as shown in Fig. 5-9A the capacity code row is read from left to right.

First dot—First significant figure
Second dot—Second significant figure
Third dot—Multiplier

The numbers corresponding to the colors are the same as for resistors, and are used in the same manner to give capacity in micro-micro-farads.

(*b*) When the voltage rating of a capacitor is other than the standard 500 volts, a dot representing the voltage rating is added in the lower (or upper) left-hand corner in the V.T. code row. These colors correspond to the same numbers as the resistor colors, but represent the number times 100 volts, except gold which is 1000 volts and silver which is 2000 volts.

(*c*) When the tolerance is other than 20%, a dot representing this tolerance is added in the V.T. code row at the right-hand side. These colors correspond to the same numbers as the resistor colors, but represent per cent tolerance.

(*d*) The body, or case color, indicates power factor. Standard power factor units are molded in a dark-brown phenolic case while the low power factor units are molded in a light tan case of material known commercially as XM-262. A black case indicates a molded paper capacitor.

(2) AMERICAN WAR STANDARDS.

The color coding of mica and molded paper capacitors according to A.W.S. is as shown in Fig. 9-B. Capacitors using this code may be most easily identified by the location of the capacity tolerance and by the color of the first significant figure which will be black for mica and silver for molded paper. This capacitor coding is the one used most generally in the Models DAS and DAS-2 equipment components.

Hold the capacitor as shown and read the capacity color code times the decimal multiplier for capacity value in M.M.F.

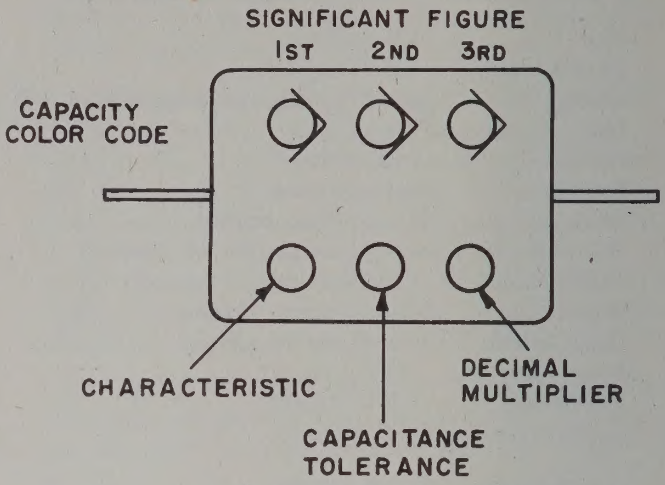
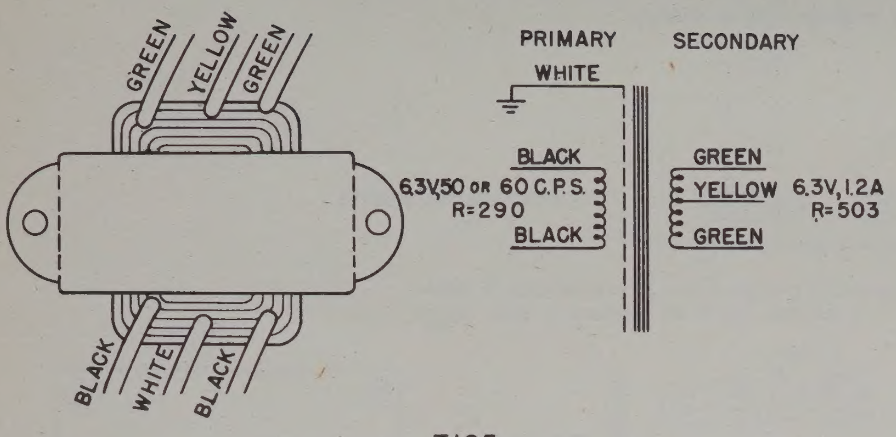
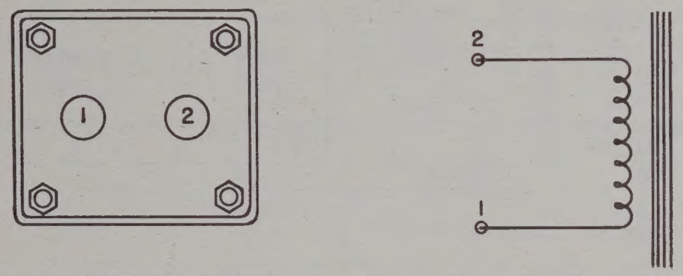


Figure 5-9B—Capacity Color Markings (AWS)

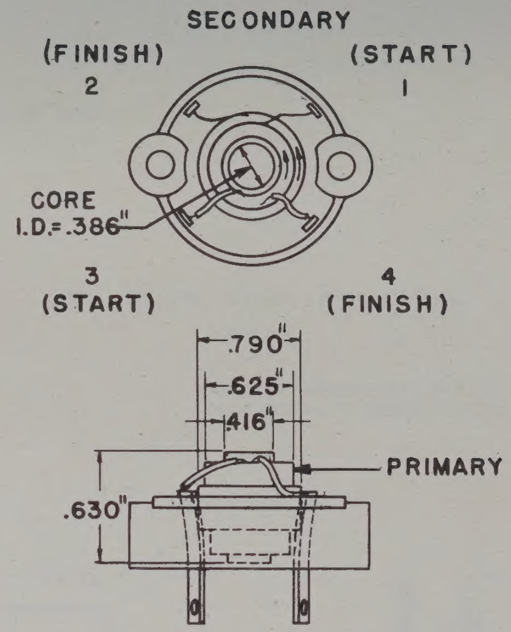

GREEN
YELLOW
GREEN
BLACK
WHITE
BLACK
PRIMARY
SECONDARY
WHITE
BLACK
6.3V,50 OR 60 C.P.S.
R=290
BLACK
GREEN
YELLOW
6.3V, 1.2A
R=503
GREEN

T105
ISOLATION TRANSFORMER



RATING: 10 HENRYS AT 10 V, 60 C.P.S. WITH 225 M.A.D.C.
D.C. RESISTANCE=107Ω ± 10%
L305
FILTER REACTOR

Figure 5-10—Transformer and Reactor Winding Data

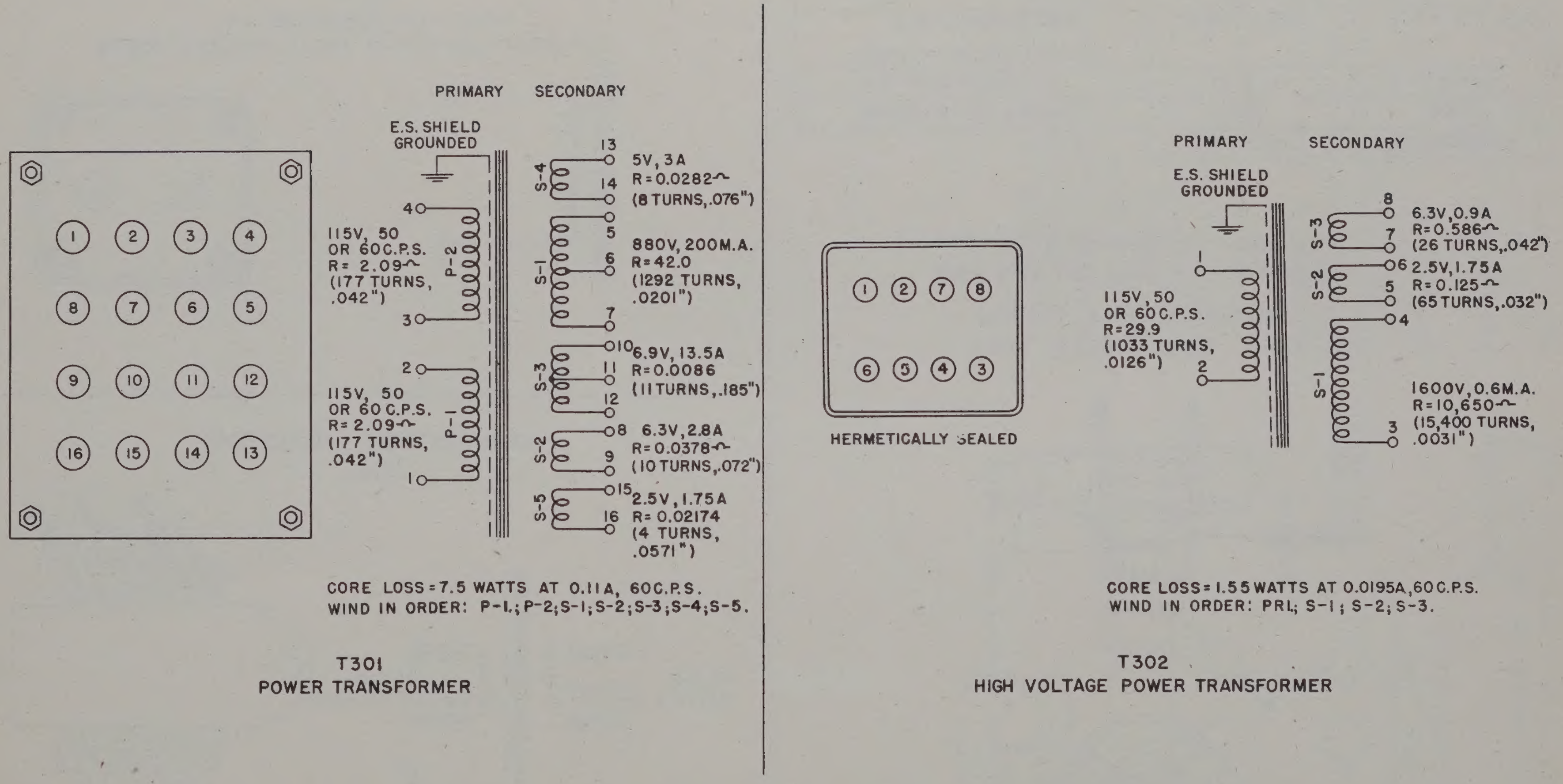

SECONDARY
(FINISH)
2
(START)
1
CORE
I.D.=.386"
3
(START)
4
(FINISH)
.790"
.625"
.416"
PRIMARY
.630"

T101, T102, T103, T104
PULSE TRANSFORMERS

WIRE SIZE AND TYPE------NO.34 E.S.
METHOD OF WINDING-----UNIVERSAL

	PRIMARY	SECONDARY
NUMBER OF TURNS	443	250
D.C. RESISTANCE	17.4 Ω	13.4 Ω
1000∼ INDUCTANCE WITH IRON CORE	4 M.H. ± 6%	1.8 M.H. ± 6%
1000∼ IN AIR	1.36 M.H. ± 2%	1.09 M.H. ± 2%
1000∼ MUTUAL WITH IRON	2.27 M.H. ± 6%	

Figure 5-11—Pulse Transformer Winding Data


PRIMARY
SECONDARY
E.S. SHIELD GROUNDED
115V, 50 OR 60C.P.S. R= 2.09~ (177 TURNS, .042")
115V, 50 OR 60 C.P.S. R= 2.09~ (177 TURNS, .042")
P-2
P-1
S-4
S-1
S-3
S-2
S-5
5V, 3A R=0.0282~ (8 TURNS,.076")
880V, 200M.A. R=42.0 (1292 TURNS, .0201")
6.9V, 13.5A R=0.0086 (11 TURNS,.185")
6.3V, 2.8A R=0.0378~ (10 TURNS,.072")
2.5V, 1.75A R= 0.02174 (4 TURNS, .0571")
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
HERMETICALLY SEALED
PRIMARY
SECONDARY
E.S. SHIELD GROUNDED
115V, 50 OR 60C.P.S. R=29.9 (1033 TURNS, .0126")
S-3
S-2
S-1
6.3V, 0.9A R=0.586~ (26 TURNS,.042")
2.5V, 1.75A R=0.125~ (65 TURNS,.032")
1600V, 0.6M.A. R=10,650~ (15,400 TURNS, .0031")
1
2
3
4
5
6
7
8

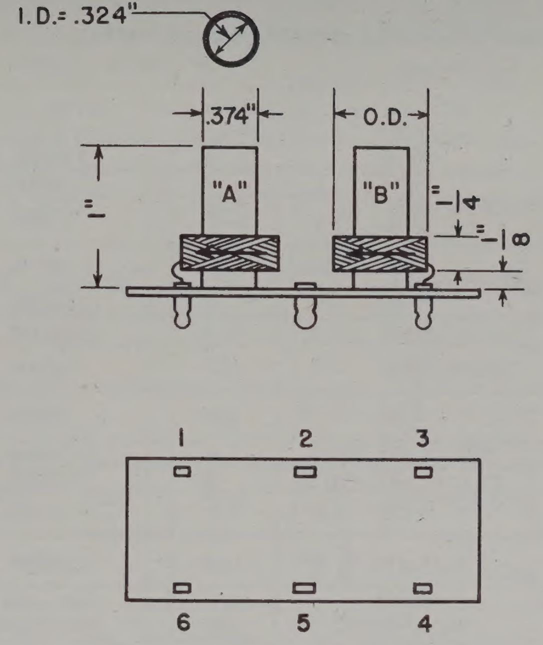
CORE LOSS=7.5 WATTS AT 0.11A, 60C.P.S.
WIND IN ORDER: P-1.; P-2; S-1; S-2; S-3; S-4; S-5.

T301
POWER TRANSFORMER

CORE LOSS=1.55 WATTS AT 0.0195A, 60C.P.S.
WIND IN ORDER: PRI.; S-1; S-2; S-3.

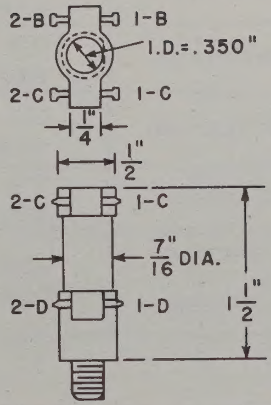
T302
HIGH VOLTAGE POWER TRANSFORMER

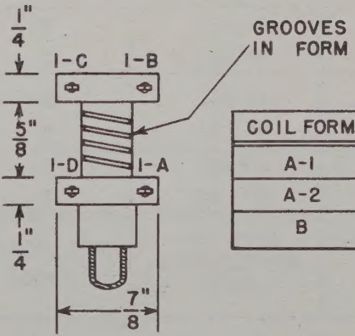
Figure 5-12—Power Transformer Winding Data



SYMBOL NUMBER	WIRE SIZE	METHOD OF WINDING	NUMBER OF TURNS	D. C. RESISTANCE	COIL POSITION	1000~ INDUCTANCE IN AIR	CONNECTIONS		O.D.
							START	FINISH	
T101	#29 E.C.	UNIVERSAL	155 169	1.70Ω 1.82Ω	A B	193μh 218μh	2 4	1 5	.605"±.015 .627"±.015
T102	#29 E.C.	UNIVERSAL	164 169	1.77Ω 1.82Ω	A B	197μh 218μh	2 4	1 5	.622"±.015 .627"±.015
T103	#29 E.C.	UNIVERSAL	164 164	1.77Ω 1.77Ω	A B	197μh 197μh	1 4	2 5	.622"±.015 .622"±.015
T104	#29 E.C.	UNIVERSAL	155 155	1.70Ω 1.70Ω	A B	193μh 193μh	1 4	2 5	.605"±.015 .605"±.015

Figure 5-13—I-F Transformer Winding Data





COIL FORM	GROOVES
A-1	40 R.H. THREADS / IN.
A-2	28 R.H. THREADS / IN.
B	NONE

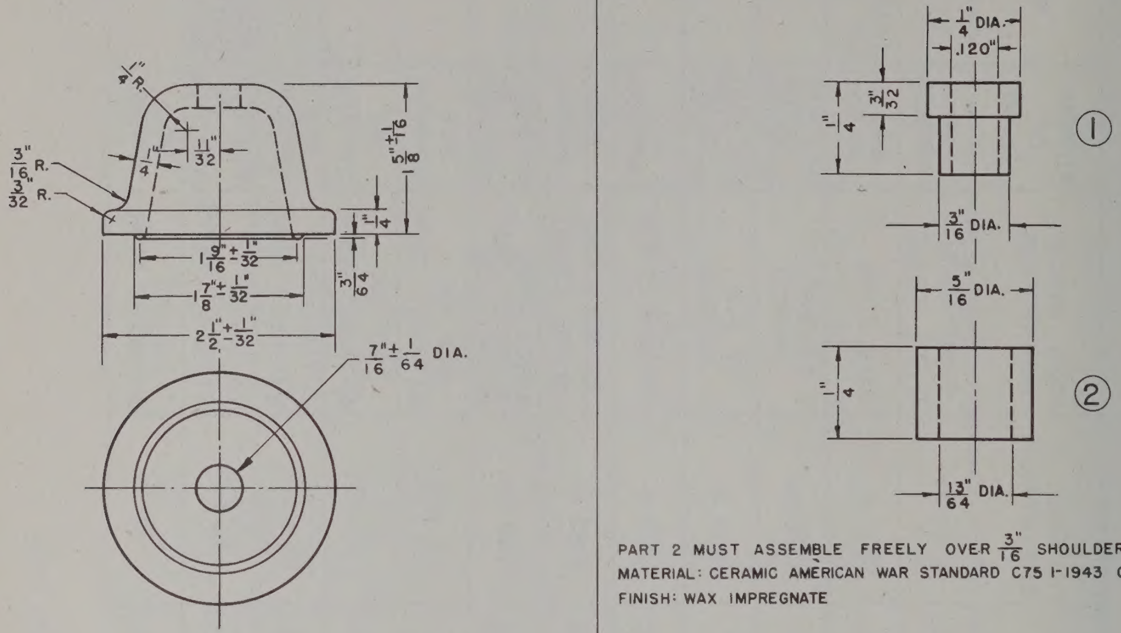
SYMBOL NUMBER	METHOD OF WINDING	WIRE SIZE AND TYPE	COIL FORM	NUMBER OF TURNS	D.C. RESISTANCE	1000~ INDUCTANCE	WINDING DIAMETER	CONNECTIONS START	TAP	FINISH
L405	SOLENOID WIND IN GROOVE	#29 F.	A-1	$15\frac{3}{4}$ TAP AT $1\frac{1}{4}$	.16Ω	2 μh	—	D-2	C-1	B-2
L406	SOLENOID WIND IN GROOVE	#29 F.	A-1	$15\frac{1}{4}$ TAP AT $1\frac{1}{4}$	.16Ω	2 μh	—	D-2	B-2	C-1
L407	UNIVERSAL	#29 E.C.	B	81¼ TAP AT 6¾	1.00Ω	60μh	5.95" ±.015	A-1	C-1	B-2
L408	UNIVERSAL	#29 E.C.	B	80¾ TAP AT 6¼	1.00Ω	60μh	5.95" ±.015	A-1	B-2	C-1
L409	SOLENOID WIND IN GROOVE	#29 F.	A-1	$14\frac{1}{2}$	.154Ω	2 μh	—	D-2	—	C-1
L410	SOLENOID WIND IN GROOVE	#29 F.	A-1	$13\frac{3}{4}$	.149Ω	2 μh	—	D-2	—	B-2
L411	UNIVERSAL	#29 E.C.	B	77¾	.955Ω	60μh	.590" ±.015	A-1	—	C-1
L412	UNIVERSAL	#29 E.C.	B	79¼	.985Ω	60μh	.590" ±.015	A-1	—	B-2
L413	SOLENOID WIND IN GROOVE	#22 F.	A-2	$10\frac{1}{4}$	.02Ω	0.90μh	—	D-2	—	C-1
L414	SOLENOID WIND IN GROOVE	#22 F.	A-2	$9\frac{3}{4}$	.02Ω	0.90μh	—	D-2	—	B-2
L415	UNIVERSAL	#29 E.C.	B	30¾	.350Ω	9μh	.515" ±.015	A-1	—	C-1
L416	UNIVERSAL	#29 E.C.	B	31¼	.350Ω	9μh	.515" ±.015	A-1	—	B-2

Figure 5-14—Receiver Tuning Coil Winding Data

SYMBOL NUMBER	COIL FORM		COIL WINDING		WIRE SIZE	METHOD OF WINDING	D.C. RESISTANCE	1000 CYCLE INDUCTANCE	NUMBER OF TURNS	NOTES
	DIAMETER	LENGTH	MAXIMUM DIAMETER	MAXIMUM LENGTH						
L102	.416" O.D. .386" I.D.	.630"	.800"	.505"	#32 EC	UNIVERSAL	15.48 Ω	6 MH ± 6% WITH CORE	560 APPROX.	
L104	.375"	1 3/4"	.727" ± .030"	1"	#32 ES	UNIVERSAL	14.0 Ω	2 MH ± 4%	541 APPROX.	Q = 35 ± 20% AT 175 K.C.
L301, L302 L303, L304	.500"	1"	1 3/4"	3/4"	#14 DC	7 LAYER PYRAMID	.025 Ω	23 μH APPROX.	9-FIRST LAYER 42-TOTAL	
L306	.375"	3/4"	1 15/32"	5/8"	#20 DC	13 LAYER PYRAMID	.217 Ω	116 μH APPROX.	13-FIRST LAYER 91-TOTAL	
L417	3300 Ω, 1 WATT RESISTOR FOR CORE		.555" ± .020"	5/16"	#29 EC	UNIVERSAL	1.33 Ω	100 μH ± 4%	140 APPROX.	
L404	.416" O.D. .386" I.D.	.630"	.900"	.505"	#38 ES	UNIVERSAL	223 Ω	60 MH ± 6% WITH CORE	1800 APPROX.	
L400	.500" O.D. .375" I.D.	2 31/64"	1 1/16" ± 1/32"	1 7/16"	#34 ES	5 PI UNIVERSAL	137 Ω	40 MH ± 4% WITHOUT CAN WITH CORE	475 PER PI 2375 TOTAL	
L401	SEE RECEIVER TUNING COIL FORM B		.656" ± .015"	3/8"	7-41 ES LITZ	UNIVERSAL	6.6 Ω	625 MH WITHOUT CORE	248 APPROX.	
L402	SEE RECEIVER TUNING COIL FORM B		.594" ± .015"	3/8"	7-41 ES LITZ	UNIVERSAL	4.1 Ω	252 MH WITHOUT CORE	162 APPROX.	
L403	SEE RECEIVER TUNING COIL FOR B		.683" ± .015"	3/8"	7-41 ES LITZ	UNIVERSAL	7.1 Ω	718 MH WITHOUT CORE	269 APPROX.	
L101	.477" O.D. .419" I.D.	1.115"	.900"	.900"	#36 ES	3 PI UNIVERSAL	105 Ω	18.9 MH WITHOUT CORE	490 PER PI 1470 TOTAL	INDUCTANCE RANGE TO EXCEED ±20% AT 1 K.C.
L103	.416" O.D. .386" I.D.	.630"	.900	.505"	#34 ES	UNIVERSAL	46 Ω	7.5 MH WITHOUT CORE	990 APPROX.	

Figure 5-15—Choke Coil Winding Data

MATERIAL: APPROVED INSULATING MATERIAL IN ACCORDANCE WITH BU. ENG. SPEC. RE 13A 317 GRADE F OR G. TYPE 61023 PER NAVY RE61A204

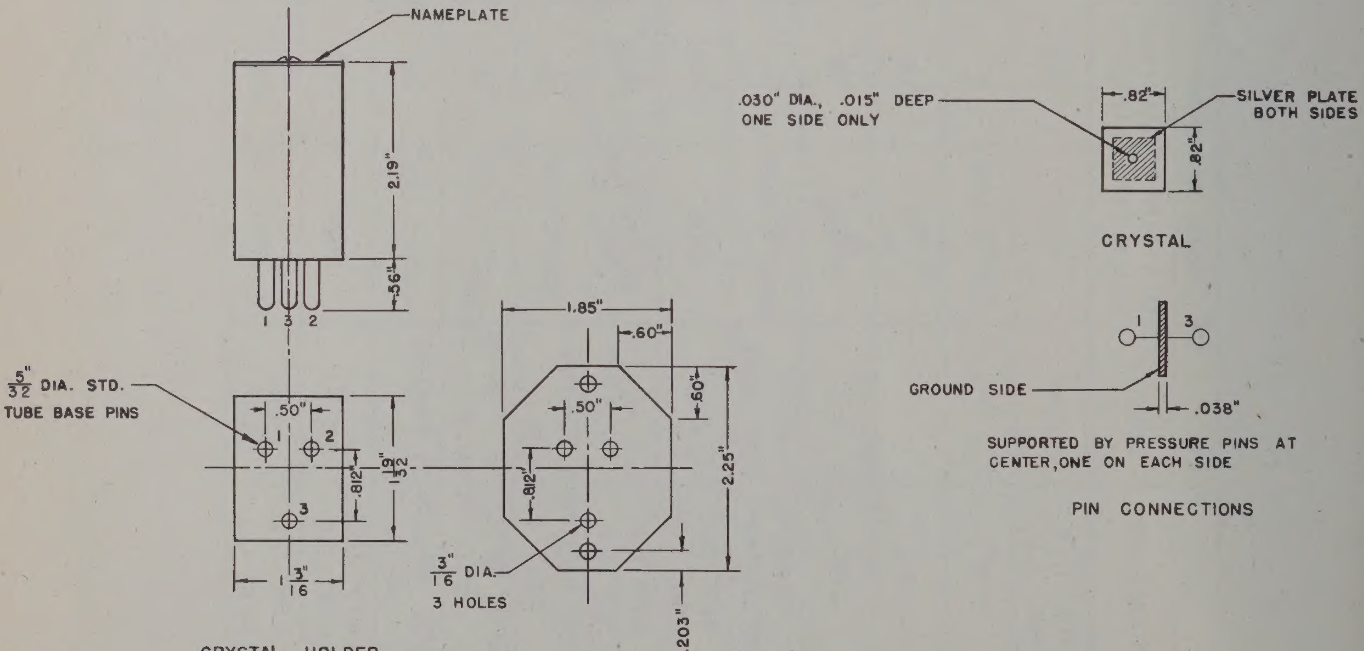

1/4" R.
3/16" R.
3/32" R.
1/4"
11/32"
5" ± 1/16
1 5/8
1/4"
3/64"
1 9/16" ± 1/32"
1 7/8" ± 1/32"
2 1/2" ± 1/32"
7/16" ± 1/64 DIA.
1/4" DIA.
.120"
3/32"
1/4"
①
3/16" DIA.
5/16" DIA.
1/4"
②
13/64" DIA.

PART 2 MUST ASSEMBLE FREELY OVER $\frac{3}{16}$" SHOULDER OF PART 1
MATERIAL: CERAMIC AMERICAN WAR STANDARD C75 1-1943 CLASS L GRADE L3
FINISH: WAX IMPREGNATE

INSULATOR SHELL FOR ANTENNA LOADING-COIL UNIT

STAND OFF INSULATORS

Figure 5-16—Replaceable Ceramic Insulator Drawings


NAMEPLATE
2.19"
.56"
1
3
2
5/32" DIA. STD. TUBE BASE PINS
.50"
1
2
3
.812"
1 9/32"
1 3/16"
1.85"
.60"
.50"
.60"
.812"
2.25"
3/16" DIA. 3 HOLES
.203"
.030" DIA., .015" DEEP ONE SIDE ONLY
.82"
SILVER PLATE BOTH SIDES
.82"
1
3
GROUND SIDE
.038"

CRYSTAL HOLDER

CRYSTAL SOCKET

CRYSTAL

SUPPORTED BY PRESSURE PINS AT CENTER, ONE ON EACH SIDE

PIN CONNECTIONS

Figure 5-17—Crystal Holder Drawing

TABLE I
LIST OF MAJOR UNITS
FOR
NAVY MODEL DAS AND DAS-2 EQUIPMENTS

NAVY TYPE DESIGNATION	NAME OF MAJOR UNIT	SYMBOL GROUP	ASSEMBLY DRAWING
CG-46210*	Radio Receiver-Indicator	100–400	W-19J707
CG-55147	Indicator	100–200	W19J702
CG-46244	Receiver	300	W19J690
CG-20288	Rectifier-Power Supply	400	T41J484
CALM 10323	Mounting Rack	None	W19J662
CG-47335	Antenna Loading-Coil	500	P-36J627

*Suffix A after type number denotes ability to receive pulse signals at two basic repetition rates. Suffix B denotes ability to receive two pulse rates and that all four Receiver CHANNELS cover the same frequency range.

TABLE II
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig- nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig- nation	G.E. Co. Dwg. and Part No.	All Symbol Desig- nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
A101	Cabinet Support	Shock Mount			548		M48J423-1	A101	0.85					1	2	2	14
A102	CRT Shield Support	Bracket			137		K43J426	A102	.18					1	1	1	1
C101	Crystal Isol.Cap.	Cap., Mica 3600 mmf ±5%, 500 v.	*CM35B3265		27	Per GE Dwg.	K44J899-4	C101, 191	.27	1	1			1	1	1	2
C102	Crystal Freq. Control	Cap., Air Trimmer 50 mmf Max.	-482005	RE13A317F	16	Per GE Dwg.	K44J619-3	C102	1.14	1	1			1	1	3	1
C103	Crystal Tuning Cap.	Cap., Ceramic 1.5 mmf O.T.C. ±20%	-481856-20		8	CBN	K-34J238-2	C103	.12	1	1			1	1	3	1
C104	Crystal Tuning Cap.	Cap. Ceramic 2.2 mmf O.T.C. ±20%	-481857-20		8	CBN	K-34J238-3	C104	.12	1	1			1	1	3	1
C105	Osc. Coupling Cap.	Cap. Ceramic 4.7 mmf O.T.C. ±10%	-481859-10		8	CBN	K-34J238-48	C105	0.16	1	1			1	1	3	1

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C106	Osc. Tuning Cap.	Cap. Silver Mica 300 mmf. ±5%, 500 V.	*CM20D301J	C75.3	16	....	K-44J898-13	C106	.21	1	1	....	....	1	1	3	1
C107	Osc. Plate By-Pass Cap.	Cap. Paper, 6000 mmf ±20%, 600 V.	-481838-20	RE13A488	7	#CD	K-43J459-6	C107, 195	.15	1	1	....	....	1	1	3	5
C108	Phase Set Coupling Cap.	Cap. Ceramic 47 mmf ±10% O.T.C.	-481532-10	....	8	Per GE Dwg.	K-34J238-58	C108, 114, C166, 174	.05	1	2	....	....	1	1	3	4
C109	Phase Set Tuning Cap.	Cap. Mica 390 mmf ±5%, 500 V.	*CM20B991J	C75.3	24	....	K-44J902-62	C109, 150	.12	1	1	....	....	1	1	3	2
C110	Phase Set Tuning Cap.	Cap. Mica 200 mmf ±5%, 500 V.	*CM20B201J	C75.3	24	....	K-44J902-50	C110, 111	.09	1	1	....	....	1	1	3	2
C111	Phase Set Tuning Cap.	Same as C110															
C112	Cathode Res. By-Pass, 10 u sec. Marker	Cap. Moulded Paper, .01 mf ±20%, 400 V.	-481839-20	RE13A488	7	DIM	K-43J459-10	C112, 143	.32	1	3	....	....	1	1	3	5
C113	Crystal Buffer Coupling	Cap. Mica 330 mmf ±10%, 500 V.	*CM20B331K	C75.3	24	....	K-44J902-59	C113	.12	1	1	....	....	1	1	3	1
C114	10 u sec. Marker Coupling	Same as C108															
C115	Crystal Buffer Coupling	Cap. Ceramic 33 mmf ±10%, O.T.C.	-481862-10	....	8	Per GE Dwg.	K-34J238-56	C115	.05	1	1	....	....	1	1	3	1
C116	1st Counter Storage Cap.	Cap. Mica 510 mmf ±5%, 500 V.	*CM20B511J	C75.3	24	....	K-44J902-68	C116	.13	1	1	....	....	1	1	3	1
C117	1st Counter Cathode By-Pass	Cap. Paper 0.5 mf ±10%, 600 V.	-48704-A10	RE13A488	31	XDMRB6-5-10	K-43J249-9	C117, 141 C149, 164	.95	1	2	....	....	1	2	3	10
C118	Marker Mixer Coupling	Cap. Ceramic 68 mmf O.T.C. ±10%	-481863-10	....	8	Per GE Dwg.	K-34J238-60	C118	.90	1	1	....	....	1	1	3	1
C119	1st Counter Output Coupling	Cap. Air Trimmer 68 mmf Max.	-482004	RE13A317F	16	Per GE Dwg.	K-44J619-1	C119	1.19	1	1	....	....	1	1	3	21
C120	2nd Counter Storage	Cap. Mica 2400 mmf ±5%, 500 V.	*CM30B242J	C75.3	483	....	K-44J897-32	C120, 123	.27	1	1	....	....	1	1	1	2
C121	2nd Counter Cathode By-Pass	Cap. Paper 10 mf ±10%, 500 V.	-481852-10	RE13A488	10	23F226	K-44J334-8	C121, 124, C128, 187, C198	1.34	1	3	....	....	1	3	3	13

*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C122	2nd Counter Output Coupling	Cap. Ceramic 33 mmf O.T.C. ±5%	-481862-5	....	8	CBN	K-34J238-147	C122	$0.09	1	1	.....		1	1	3	1
C123	3rd Counter Storage	Same as C120															
C124	3rd Counter Cathode By-Pass	Same as C121															
C125	Marker Mixer Coupling	Cap. Ceramic 91 mmf Max. Neg. Coef. ±5%	-481877-5	....	8	Per GE Dwg.	K-34J238-7158	C125	.09	1	1	.....		1	1	3	1
C126	3rd Counter Output Coupling	Cap. Ceramic 43 mmf ±5% O.T.C.	-481866-5	....	8	Per GE Dwg.	K-34J238-150	C126	.09	1	1	.....		1	1	3	1
C127	4th Counter Storage	Cap. Mica 3900 mmf ±5% 500 V.	*CM35B392-J	C75.3	27	....	K-44J899-5	C127	.34	1	1	.....		1	1	3	1
C128	4th Counter Cathode By-Pass	Same as C121															
C129	Test Jack Isolating Capacitor	Cap. Ceramic 100 mmf Max. Neg. Coef. ±10%	-481604-10	....	8	Per GE Dwg.	K-34J238-7062	C129, 130	.05	1	1	.....		1	1	3	2
C130	4th Counter Output Coupling	Same as C129															
C131	500 u sec. Output Coupling	Cap. Ceramic 47 mmf ±5% O.T.C.	-481532-5	....	8	Per GE Dwg.	K-34J238-151	C131, 438, 439, 440	.05	1	3	.....		1	2	3	4
C132	Time Corrector Grid Coupling	Cap. Ceramic 240 mmf Max. Neg. Coef. ±5%	-481878-5	....	8	Per GE Dwg.	K-34J238-7168	C132, 133, 134	.05	1	2	.....		1	1	3	3
C133	Time Corrector Grid Coupling	Same as C132															
C134	Time Corrector Output Coupling	Same as C132															
C135A	Time Corrector Plate By-Pass	Cap. Paper 0.1 mf ±20%, 600 W.V.D.C.	-48849-A20	RE13A488	10	Per GE Dwg.	K-35J639-2	C135A,B,C, C403A,B,C, C408A,B,C, C414A,B,C, C420A,B,C, C445A,B,C	.97	1	4	.....		1	4	3	16

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C135B	Time Delay Grid By-Pass	Same as C135A															
C135C	E.-J. Cathode By-Pass	Same as C135A															
C138	E.-J. Grid Coupling	Cap. Ceramic 10 mmf O.T.C. ±5%	–481864-5	....	8	Per GE Dwg.	K-34J238-135	C138, 139	.11	1	1	...	...	1	1	3	2
C139	E.-J. Grid Coupling	Same as C138															
C140	E.-J. Grid Coupling	Cap. Ceramic 27 mmf ±5% O.T.C.	–481861-5	....	8	CBN	K-34J238-145	C140, 144	.07	1	1	...	...	1	1	3	2
C141	Balance Gain Output Coupling	Same as C117															
C142	Balance Grid By-Pass	Cap. Mica 1000 mmf ±10%, 500 W.V.D.C.	*CM30D102K	C75.3	27	Per GE Dwg.	K-44J900-25	C142	.22	1	1	...	...	1	1	3	1
C143	Pedestal Output Coupling	Same as C112															
C144	E.-J. Grid Coupling	Same as C140															
C145	500 u sec. Grid Coupling	Cap. Ceramic 27 mmf ±10% O.T.C.	–481861-10	....	8	CBN	K-34J238-55	C145, 172	.05	1	1	...	...	1	1	3	2
C146	Marker Mixer Grid Coupling	Cap. Ceramic 51 mmf ±5% Max. Neg. Coef.	–481876-5	....	8	Per GE Dwg.	K-34J238-7152	C146	.09	1	1	...	...	1	1	3	1
C147A	Marker Mixer Grid By-pass	Cap. Paper 0.1 mf ±20%, 600 W.V.D.C.	–481846-20	....	31	Per GE Dwg.	K-43J249-2	C147A, B, 170A,B, C183A,B,C	.91	1	3	...	...	1	2	3	8
C147B	Line Delay Grid By-pass	Part of C147A															
C149	T.S. Mixer Output	Same as C117															
C150	Marker Mixer Output	Same as C109															
C151	Feed-back Trimmer	Cap. Air 50 mmf Station Selector	–482069	RE13A317F	16	Per GE Dwg.	K-44J619-2	C151, 152, 162	.97	1	2	...	...	1	2	3	6
C152	Feed-back Trimmer	Same as C151															
C153	Feed-back capacitor	Cap. Ceramic 22 mmf ±5%	–481865-5	....	8	Per GE Dwg.	K-34J238-143	C153	.09	1	1	...	...	1	1	3	1

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C154	Feed-back Trimmer.	Air Trimmer Max. Cap. 54 mmf Min. Cap. 410 mmf 14 Plate 0.015″ Plate Spacing	....	RE13A317F	16	....	K-44J619	C154, 160	.91	1	1	.....	.....	1	1	3	4
C155	Feed-back capacitor.	Cap. Ceramic 51 mmf ±5%	−481870-5	....	8	CBN	K-34J238-1152	C155	.12	1	1	.....	.....	1	1	3	1
C156	Feed-back Trimmer.	Air Trimmer Max. Cap. 54 mmf Min. Cap. 410 mmf 14 Plate 0.015″ Plate Spacing	....	RE13A317F	16	....	K-44J619-5	C156, 158	.91	1	1	.....	.....	1	1	3	4
C157	Feed-back Capacitor.	Cap. Ceramic 75 mmf ±5%	−481871-5	....	8	CBN	K-34J238-1156	C157	.12	1	1	.....	.....	1	1	3	1
C158	Feed-back Trimmer.	Same as C156															
C159	Feed back Capacitor.	Cap. Ceramic 100 mmf ±5%	−481872-5	....	8	Per GE Dwg.	K-34J238-1159	C159	.12	1	1	.....	.....	1	1	3	1
C160	Feed back Trimmer.	Same as C154															
C161	Feed back Capacitor.	Cap. Ceramic 130 mmf ±5%	−481873-5	....	8	Per GE Dwg.	K-34J238-1162	C161	.12	1	1	.....	.....	1	1	3	1
C162	Feed-back Trimmer.	Same as C151															
C163	Feed-back Capacitor.	Cap. Ceramic 160 mmf ±5%	−481874-5	....	8	Per GE Dwg.	K-34J238-1164	C163	.12	1	1	.....	.....	1	1	3	1
C164	T.S. Isol. Capacitor.	Same as C117															
C165	E.-J. Coupling Capacitor	Cap. Ceramic 220 mmf ±10% Max. Neg. Coef.	−481875-10	....	8	Per GE Dwg.	K-34J238-7066	C165	.09	1	1	.....	.....	1	1	3	1
C166	500 u sec. Coupling Capacitor	Same as C108															
C167	Coarse Delay Grid Coupling	Cap. Mica .03 mf ±5%, 600 W.V.D.C.	*CM50B303J	C75.3	329	Per GE Dwg.	K-44J915-1	C167	1.35	1	1	.....	.....	1	1	3	1

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C168	T.C.Output Coupling	Cap. Paper 0.1 mf± 10% 400 W.V.D.C.	-481027-10	RE13A488	17	CMR	K-35J604-1	C168, 181, 182, 196, 197, 202	.19	1	3	...	...	1	3	3	15
C169	Crystal Tuning Cap	Cap. Ceramic 100 mmf ±5% O.T.C.	-481868-5	....	8	CBN	K-34J238-159	C169	.07	1	1	...	...	1	1	3	1
C170A	Coarse Delay Grid By-pass	Same as C147A															
C170B	Coarse Delay Grid By-pass	Same as C147A															
C172	Coupling Capacitor.	Same as C145															
C173	Time Constant—Coupling Capacitor	Cap. Mica .01 mf ±5% 300 W.V.D.C.	*CM35B103J	C75.3	...	Per GE Dwg.	K-44J901-1	C173	.62	1	1	...	...	1	1	3	1
C174	2500 u sec. coupling cap.	Same as C108															
C175	Coupling Cap.	Cap. Mica 470 mmf ±10%, 500 W.V.D.C.	*CM20B471K	C75.3	24	Per GE Dwg.	K-44J902-66	C175, 186, 200, 201, 444	.11	1	3	...	...	1	2	3	5
C176	Output Coupling—Differentiating Capacitor	Cap. Mica 680 mmf ±5% 500 W.V.D.C.	*CM30B681J	C75.3	483	Per GE Dwg.	K-44J897-8	C176	.13	1	1	...	...	1	1	3	1
C177	Trace Length Balancing Coupling Capacitor	Cap. Ceramic Trimmer 125 mmf Max.	-482007	....	8	....	K-44J534-1	C177	.74	1	1	...	...	1	1	3	1
178A	CRT Grid By-pass Condenser	Cap. Paper 0.1 mf ±20%, 600 W.V.D.C.	-481847-20	RE13A488	7	DYR6111	K-43J251-2	C178A,B,C	1.08	1	1	...	...	1	1	3	3
C178B	CRT Cathode By-pass	Same as C178A															
C178C	CRT Cathode By-pass	Same as C178A															
C181	Coupling Cap.	Same as C168															
C182	2500 u sec. coupling cap.	Same as C168															
C183A	Screen By-pass Con.	Same as C147A															
C183B	Cathode By-pass Con.	Same as C147A															
C183C	Grid Filter Cap.	Same as C147A															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C186	Coupling Cap.	Same as C175															
C187	Grid Bias Filter Cap.	Same as C121															
C188	Coupling Cap.	Cap. Ceramic 110 mmf ±5% O.T.C.	–481869-5	....	8	CBN	K-34J238-160	C188	.05	1	1	...	...	1	1	3	1
C189	Pedestal Time Constant Cap.	Cap. Mica 360 mmf±5% 500 W.V.D.C.	*CM20D361J	C75.3	16	Per GE Dwg.	K-44J898-19	C189	.19	1	1	...	...	1	1	3	1
C190	Pedestal Time Constant Cap.	Cap. Mica 1,300 mmf ±5% 500 W.V.D.C.	*CM30B132J	C75.3	483	Per GE Dwg.	K-44J897-21	C190	.19	1	1	...	...	1	1	3	1
C191	Pedestal Time Constant Cap.	Same as C101															
C192	Crystal Tuning Cap.	Cap. Ceramic 51 mmf O.T.C.	–481867-5	....	8	Per GE Dwg.	K-34J238-152	C192	.05	1	1	...	...	1	1	3	1
C193	CRT Blanking Coupling Capacitor	Cap. Paper 0.1 mf 3,000 W.V.D.C.	–481836-10	RE13A488	27	Per GE Dwg.	K-44J919	C193	2.64	1	1	...	...	1	1	3	3
C194	Sweep Time Constant Cap.	Cap. Mica 1,000 mmf ±5% 500 W.V.D.C.	*CM30B102J	C75.3	483	Per GE Dwg.	K-44J897-15	C194	.16	1	1	...	...	1	1	3	1
C195	Feed-back Isolation Cap.	Same as C107															
C196	Coupling Cap.	Same as C168															
C197	Coupling Cap.	Same as C168															
C198	+B Filter Cap.	Same as C121															
C199	Fine Delay Time Constant Cond.	Cap. Mica 1,500 mmf ±5%, 500 W.V.D.C.	*CM30B152J	C75.3	483	Per GE Dwg.	K-44J897-22	C199	.21	1	1	...	...	1	1	3	1
C200	Coupling Cap.	Same as C175															
C201	Blanking Delay Cap.	Same as C175															
C202	CRT Plate Isolation Cap.	Same as C168															

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C301	Input Filter Cap.	Cap. Paper 10 mf±10%, 1,000 V.	–481845-10	RE13A-488	10	....	K-43J308-9	C301	4.05	1	1	...	...	1	1	3	3
C302	Output Filter Cap.	Cap. Paper 10 mf±10% 600 V.	–481845-10	RE13A-488	10	....	K-43J308-8	C302, 305	3.63	1	1	...	...	1	1	3	5
C303A	Coupling Cap.	Cap. Paper 0.1 mf±10%, 600 W.V.D.C.	–481829-10	RE13A-488	10	CG	K-35J639-11	C303	1.05	1	1	...	...	1	1	3	3
C303B	Filter Cap.																
C305	+B Filter cap.	Same as C302															
C306A	Minus H.V. Filter	Cap. Paper 3 x 0.1 MFD ±10%, 3,000 V.	....	....	...	....	K-44J391-1	C306	3.98	1	1	...	...	1	1	3	3
C306B	Minus H.V. Filter	Same as C306A															
C306C	Plus H.V. Filter	Same as C306A															
C309A	Line Filter Cap.	Cap. Paper 0.25 mf ±20%, 600 W.V.D.C.	–48127-20	RE13A488	10	CG	K-35J639-9	C309, 310	.78	1	1	...	...	1	1	3	5
C309B	Line Filter Cap.	Same as C309A															
C310A	Line Filter Cap.	Same as C309A															
C310B	Line Filter Cap.	Same as C309A															
C403A	Cathode By-pass V401	Same as C135A															
C403B	Screen By-pass V401	Same as C135A															
C403C	Plate By-pass V401	Same as C135A															
C407	Coupling Cap. V402	Cap. Mica 100 mmf±5%, 500 W.V.D.C.	*CM20B101J	C75.3	24	....	K-44J902-37	C407	.11	1	1	...	...	1	1	3	1
C408A	Plate By-pass V402	Same as C135A															
C408B	Screen By-pass V402	Same as C135A															
C408C	Cathode By-pass V402	Same as C135A															
C414A	Cathode By-pass V403	Same as C135A															
C414B	Screen By-pass V403	Same as C135A															
C414C	Plate By-pass V403	Same as C135A															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig nation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C420A	Cathode By-pass V404	Same as C135A															
C420B	Screen By-pass V404	Same as C135A															
C420C	Plate By-pass V404	Same as C135A															
C425	Cathode By-pass V405	Cap. Paper 0.01 mf ±20%, 400 W.V.D.C.	-481839-20	RE-13A488	7	DIM	K-43J459-10	C425, 434, 446	.33	...	...	...	...	1	2	3	8
C426	Screen By-pass V405	Cap. Mica 3300 mmf ±10%, 500 W.V.D.C.	*CM30B332K	C75.3	483	....	K-44J897-37	C426	.28	1	1	...	...	1	1	3	1
C432	OSC Tuning—Temp. Compensation Cap.	Cap. Ceramic 150 mmf ±5%	-481944-5	....	8	....	K-34J238-2163	C432	.12	1	1	...	...	1	1	3	1
C433	Video Filter Cap.	Cap. Silver Mica 910 mmf ±5%, 300 W.V.D.C.	*CM20D911J	C75.3	329	....	K-47J516-2	C433	.35	1	1	...	...	1	1	3	1
C434	V407 Coupling Cap.	Same as C425															
V435	Video Filter Cap.	Cap. Silver Mica 620 mmf ±5%, 300 W.V.D.C.	*CM20D621J	C75.3	329	....	K-47J516-1	C435	.32	1	1	...	...	1	1	3	1
C436	Video Filter Cap.	Cap. Silver Mica 390 mmf ±5%, W.V.D.C.	*CM20D391J	C75.3	16	....	K-44J898-21	C436	.21	1	1	...	...	1	1	3	1
C437	Video Output Coupling	Cap. Paper 1 mf±10%, 500 W.V.D.C.	-481854-10	RE13A488	10	23F215	K-44J334-5	C437, 443	1.37	1	1	...	...	1	1	3	5
C438	R.F. Tuning Cap.	Cap. Ceramic 47 mmf ±5%	-4819	....	8	....	K-34J238-151	C438, C439, C440	.15	...	...	...	...	...	...	3	3
C439	Converter Tuning Cap.	Same as C438															
C440	OSC. Grid Cap.	Same as C438															
C441	OSC. Tuning Cap. Temp. Compensating	Cap. Ceramic 100 mmf ±5%	-481945-5	....		8 CBN	K-34J238-4159	C441	.09	1	1	...	...	1	1	3	1
C442	OSC. Tuning Cap.	Cap. Silve r Mica 1,000 mmf±5%, 500 W.V.D.C.	*CM30D102J	C75.3	27	....	K-44J900-24	C442	.26	1	1	..	..	1	1	1	1

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
C443	Screen By-pass V407	Same as C437															
C444	RF By-pass V401 Plate	Same as C175															
C445A	Cathode By-pass V405	Same as C135A															
C445B	B+ By-pass	Same as C135A															
C445C	Plate By-pass V405	Same as C135A															
C446	OSC By-pass	Same as C425															
E101	Framing Control	Knob	...	...	...	...	V-39J390	E101	2.06	..	..	1	1	..	..	1	1
E102	Freq. Control	Knob.	...	...	...	Per GE Dwg.	V-45J825	E102	.43	..	..	1	1	..	..	1	1
E103	Focus & Intensity Pot. Covers	High Voltage Shield	...	...	10	...	V-32J227	E103	.16	..	..	1	1	1	1	1	4
E401	OSC. Lead Support	Stand-Off	...	...	...	...	V-45J345-1	E401	.11	..	..	1	1	..	0	..	0
E402	OSC. Lead Support	Stand-Off	...	...	...	...	V-45J345-2	E402	.11	..	..	1	1	..	0	..	0
E403	OSC. Lead Support	Stand-Off	...	...	...	...	V-45J345-3	E403	.14	..	..	1	1	..	0	..	0
E404	Feed thru Bushing	Stand-Off (Ceramic)	...	C75.1-1943	106	#B-553	V-45J765-1	E404	.01	..	..	1	2	1	4	3	14
E405	Feed thru Bushing	Stand-Off (Ceramic)	...	C75.1-1943	106	#B-553	V-45J765-2	E405	.01	..	..	1	2	1	4	3	14
E501	Ant. Feed thru Bushing	Insulator Shell Assembly	...	...	137	Per GE Dwg.	K-52J70	E501	1.40	..	..	1	1	1	1	1	2
F301	115V Line 5 amp. Fuse	Fuse— 5 Amp. for 115V	...	...	...	#1094	...	F301	.05	1	10	..	..	1	10	1	50
F301A	230V Line 5 amp. Fuse	Fuse—5 Amp. for 230V	...	...	...	#1092	...	F301A	.05	1	10	..	..	1	10	1	50
H101	Crystal Hold-down Clamp	Clamp (crystal)	...	...	200	Per GE Dwg.	K-47J18	H101	.09	..	..	..	..	1	1	1	1
H102	Glass tube Hold-down Clamp	Tube Clamp (glass)	...	...	200	Per GE Dwg.	K-47J228-1	H102	.03	..	..	..	..	1	7	1	13
H103	Metal Tube Hold-down Clamp	Tube Clamp (metal)	...	...	200	Per GE Dwg.	K-44J677	H103, 401	.03	..	..	1	2	1	6	1	10
H104	V122 Holding Clamp	Clamp (tube)	...	...	137	Per GE Dwg.	K-8078970-G1	H104	.24	..	..	..	..	1	1	1	1
H105	Scope-Window	Thumb Screw	...	...	...	Per GE Dwg.	V-45J206	H105	.68	..	..	..	..	..	0	1	4

*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
H106	Unit Slide Stop	Stop Spring and Block Assembly	....	....	137	Per GE Dwg.	K-47J268	H106	2.00	..	..	..	..	..	..	1	1
H108	Mica Cap. Sup. Clip	Supporting Clip	....	....	...	Per GE Dwg.	K-47J621-1	H108	.12	..	..	..	..	..	..	1	20
H109	Mica Cap. Sup. Clip	Supporting Clip	....	....	...	Per GE Dwg.	K-47J621-2	H109	.12	..	..	..	..	..	..	1	6
H110	Pot. Shaft Clamp	Lock (pot)	....	....	...	Per GE Dwg.	K-43J395	H110, 303	.06	..	..	..	..	..	..	1	13
H112	Strip Holding	Thumb Screw	....	....	...	....	M-29J693-20	H112	3.42	..	..	..	..	..	..	1	2
H113	Unit Holding	Thumb Screw	....	....	...	....	M-29J693-19	H113	3.03	..	..	..	..	..	..	1	8
H301	Holding Clamp	Cable Clamp (power)	....	AN3057-12-6	160	....	K-34J274-4	H301	.45	..	..	1	1	1	1	1	2
H302	V301, 2 & 3 Tube Clamps	Tube Clamp	....	....	117	8527	DL4W270A-144	H302	.02	..	..	..	..	1	1	1	2
H303	Pot. Shaft Clamp	Same as H110															
H304	AC-Line Fuse Holder	Fuse Holder	....	....	...	Per GE Dwg.	K-34J902	H304	.18	..	..	..	..	1	1	1	1
H305	Spare Fuse Clips	Fuse Clip #1086 Littel Fuse or equiv.	....	....	...	#1086	DL4W270A-212	H305	.02	..	..	..	..	1	1	1	8
H306	H.V. Rect. Plate Cap.	Plate Cap	....	RE-13A-317F	158	Per GE Dwg.	K-35J903	H306	.14	..	..	1	1	..	..	1	1
H307	#10 Allen Set-screw	Wrench #10	....	....	102	Per GE Dwg.	K-7868935-2	H307	.02	1	2	..	..	1	2	1	4
H308	#8 Allen Set-screw	Wrench #8	....	....	102	Per GE Dwg.	K-7868935-1	H308	.02	1	2	..	..	1	2	1	4
H309	V305 Tube Clamp	Tube Holder	....	....	...	....	K-27J760-1	H309	.04	..	..	..	..	1	1	1	1
H310	Tube Clamp Support	Tube Clamp Bracket	....	....	137	Per GE Dwg.	V-45J774	H310, 402	.21	..	..	..	..	1	4	1	5
H311	V304 Tube Clamp	Same as H102															
H401 H402	Metal Tube Clamp Tube Clamp Support	Same as H103 Same as H310															
H403	Space Heater Feed Clamp	Cable Clamp	....	....	137	Per GE Dwg.	V-39J633-1	H403	.02	..	..	..	..	..	..	1	1
I301	Holder	Panel Light-Holder	....	....	...	1920	K-34J666-3	....	1.39	..	..	..	..	1	1	1	1

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
I-302	Pilot Lamp	Pilot Lamp Mazda #44 (.25 Amp.-6.3 V.)	....	....	...	....	....	I302	.04	1	1	1	2	1	2	1	6
J101	Test Jack 50∽ Sync.	Jack—Sync. Output	....	....	...	....	K-47J922-1	J101, 102	.12	1	2	..	..	1	1	3	4
J102	Test Jack Ped. Sync.	Same as J101															
J301	Power Receptacle	Connector (Power)	AN3108-22-11S	....	137	Per GE Dwg.	K-44J907-2	J301	1.23	..	..	1	1	1	1	3	2
J401	Ant. Receptacle	Connector Receptacle	-49120	RA49F-215	137	Per GE Dwg.	K-47J207	J401	1.30	..	..	1	1	1	1	3	2
J402	Ant. Coax Plug	Connector Assembly	....	....	137	Per GE Dwg.	M-48J22	J402	4.73	1	1	1	1	1	1	3	2
L101	OSC Grid Tank	Coil–OSC. Grid 22 mh	....	....	137	Per GE Dwg.	K-47J375-1	L101	2.93	1	1	..	..	1	1	1	1
L102	OSC Plate load	Coil–OSC. Plate 6 mh	-47266	....	137	Per GE Dwg.	K-35J564-2	L102	2.94	1	1	..	..	1	1	1	1
L103	10 u sec Mark Phase Set	Coil—Phase Shift 14.5 mh	....	....	...	....	K-43J683-G1	L103	3.14	1	1	..	..	1	1	1	1
L104	10 u sec Mark Shaper	Coil—Pip 2 mh	....	....	...	....	K-43J691-G1	L104	.81	1	1	..	..	1	1	1	1
L301	A.C. Line Interference Filter	Filter Coil (line)	....	....	137	Per GE Dwg.	K-44J352-1	L301, 302, 303, 304	.46	1	2	..	..	..	0	1	4
L302	A.C. Line Interference Filter	Same as L301															
L303	A.C. Line Interference Filter	Same as L301															
L304	A.C. Line Interference Filter	Same as L301															
L305	120∽ Filter Choke..	Filter Reactor	....	....	137	Per GE Dwg.	K-44J609	L305	7.73	1	1	1	1	1	1	1	3
L306	Heater Voltage Dropping	Filament Choke	....	....	137	Per GE Dwg.	K-44J653-2	L306	1.64	1	1	..	..	..	0	1	1
L400	Diode IF Filter	Choke Coil (Diode) 40 mh ±4% out of can. Approx. 2375 turns of #34 ES Wire; DC Res. 137 ohms at 20°C.	....	....	117	2464	K-47J460	L400	1.92	..	..	1	1	1	1	1	1
L401	1st I.F. Wave Trap	Wave Trap, I.F., 625 mh; 248 turns of 7-41 ES Wire; DC Resis. 6.6 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J373-G1	L401	2.30	..	..	1	1	..	0	1	1

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
L402	2nd I.F. Wave Trap	Wave Trap, I.F., Approx. 252 mh; 162 turns 7-41 ES Wire; DC Resis. 4.1 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J373-G2	L402	2.22	..	..	1	1	..	0	1	1
L403	3rd I.F. Wave Trap	Wave Trap, I.F., Approx. 718 Micro Henries; 269 turns 7-41 ES Wire; DC Resis. 7.1 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J373-G3	L403	2.30	..	..	1	1	..	0	1	1
L404	Video Peaking Coil	Compensator Coil (Video) 60 Milli H. ±6 with core Approx. 1800 turns of 38 EC Wire; DC Resis. Approx. 300 ohms at 20°C.	....	....	...	Per GE Dwg.	K-35J564-G3	L404	2.19	..	..	1	1	1	1	1	1
L405	Ant. Tuned Inductance Band 4	Antenna Coil Band, 2 Micro Henries; 15¾ turns of 29 F Wire; DC Resis. .16 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J101-G4	L405	2.06	..	..	1	2	..	0	1	1
L406	Ant. Tuned Inductance Band 3	Antenna Coil Band 2 Micro Henries; 15¼ turns of 29F Wire; DC Resis. .16 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J101-G3	L406	2.06	..	..	1	2	..	0	1	1
L407	Ant. Tuned Inductance Band 2	Antenna Coil Band, 60 Micro Henries; Approx. 81¼ turns of 29E Wire; DC Resis. Approx. 1.00 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J101-G2	L407	1.99	..	..	1	2	..	0	1	1
L408	Ant. Tuned Inductance Band 1	Antenna Coil Band, 60 uh; Approx. 80¾ turns of 29E Wire; DC Resis. Approx. 1.00 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J101-G1	L408	1.99	..	..	1	2	..	0	1	1

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
L409	V401 Plate Tuning Inductance Band 4	Converter Coil Band, 2 MH; 14¼ turns of 29F Wire; DC Resis. .154 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J100-G4	L409	1.80	..	..	1	1	..	0	1	1
L410	V401 Plate Tuning Inductance Band 3	Converter Coil Band, 2 MH; 13¾ turns of 29F Wire; DC Resis. .149 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J100-G3	L410	1.80	..	..	1	1	..	0	1	1
L411	V401 Plate Tuning Inductance Band 2	Converter Coil Band, 60 MH; Approx. 77¾ turns of 29EC Wire; DC Resis. .955 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J100-G2	L411	1.73	..	..	1	1	..	0	1	1
L412	V401 Plate Tuning Inductance Band 1	Converter Coil Band, 60 MH; Approx. 79¼ turns of 29EC Wire; DC Resis. .985 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J100-G1	L412	1.73	..	..	1	1	..	0	1	1
L413	OSC Tank Tuning Inductance Band 4	Oscillator Coil Band, .90 MH; 10¼ turns of 22F Wire; DC Resis. Approx. .02 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J125-G4	L413	1.45	..	..	1	1	..	0	1	1
L414	OSC Tank Tuning Inductance Band 3	Oscillator Coil Band, .90 MH; 9¾ turns of 22F Wire; DC Resis. Approx. .02 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J125-G3	L414	1.45	..	..	1	1	..	0	1	1
L415	OSC Tank Tuning Inductance Band 2	Oscillator Coil Band, 9 MH in Air; Approx. 30¾ turns of 29EC Wire; DC Resis. Approx. .250 ohms at 20°C.	....	....	...	Per GE Dwg.	K-47J125-G2	L415	1.73	..	..	1	1	..	0	1	1
L416	OSC Tank Tuning Inductance Band 1	Oscillator Coil Band, 9 MH in Air; Approx. 31¼ turns of 29EC Wire; DC Resis. Approx. .350 at 20°C.	....	....	...	Per GE Dwg.	K-47J125-G1	L416	1.73	..	..	1	1	..	0	1	1
L417	OSC. Cathode Choke	Oscillator Choke Coil 1.33 ohms DC Resis. at 20°C.; Approx. 140 turns 29ES Wire	....	....	...	Per GE Dwg.	K-47J287-G1	L417	.51	..	..	1	1	1	1	1	1

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
L501	Ant. Loading Coil....	Coil Assembly 32 ohms DC Resis. at 20°C. Approx. Double Layer bank wound 91 total turns, 18EDC Wire, 46 1st layer 45 2nd layer	....	....	...	Per GE Dwg.	K-47J798-G1	L501	8.32	..	..	..	..	..	0	1	1
N101	Crystal Tuning.......	Dial Assembly.........	....	....	137	Per GE Dwg.	V-39J400-1	N101	.56	..	..	1	1	..	0	1	1
O-101	Oscillator Tuning Reduction Drive	Vernier Drive..........	....	....	...	Per GE Dwg.	V-45J918-1	O-101	3.97	..	..	1	1	..	0	1	1
O-102	Insulation for Focus Control Shaft	Tip-Shaft Extension.....	....	....	...	....	V-45J511	O-102	.23	..	..	..	..	1	1	1	4
O-103	Insulation for Intensity Control Shaft	Same as O-101															
PL301	A.C. Power Input....	Connector Receptacle (Power)	....	....	...	....	K-44J906-P1	PL301	.61	..	..	1	1	1	1	3	2
R101	Crystal Oscillator Grid Leak	Resistor, carbon 120,000 ohms ±10% ½ W.	-63360	....	6	EB	M-31J353-87	R101	.01	1	1	..	..	1	1	4	3
R102	Oscillator Plate Filter	Resistor, carbon 2,200 ohms ±10% 1 W.	-63288	....	6	GB	M-31J373-66	R102, R200, 147	.02	1	2	..	..	1	2	4	8
R103	10 usec Marker Phase Shift Control	Potentiometer 2 Meg. ±20% Tapered	-631678-20	....	11	35	K-43J587	R103	.28	1	1	..	..	1	1	4	5
R104	10 usec Marker Shape Grid Leak	Resistor, carbon 1 Meg. ±10% ½ W.	-63360	....	6	EB	M-31J353-98	R104, 181	.01	1	1	..	..	1	1	4	5
R105	Damping Resistor for L104	Resistor, carbon 750 ohms ±5% ½ W.	-63355	....	6	EB	M-31J353-156	R105	.02	1	1	..	..	1	1	4	3
R106	Cathode Bias for 10 usec Marker Shaper	Resistor, carbon 22,000 ohms ±10% 1 W.	-63288	....	6	GB	M-31J373-78	R106, 174	.02	1	1	..	..	1	1	4	5
R107	100 KC Coupling...	Resistor, carbon 39,000 ohms ±10% ½ W.	-63360	....	6	EB	M-31J353-81	R107	.01	1	1	..	..	1	1	4	3

*American War Standards Number.

Symbol Desig- nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig- nation	G.E. Co. Dwg. and Part No.	All Symbol Desig- nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R108	Crystal Buffer Grid Leak	Resistor, carbon 100,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-86	R108, 136, 166, 171, 175, 193, 204, 220, 262, 277, 254	.01	1	6	..	..	1	6	4	30
R109	Crystal Buffer Plate Load	Resistor, carbon 10,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-74	R109, 223	.02	1	1	..	..	1	1	4	5
R110	Grid Side Damping Resistor for T101	Resistor, carbon 11,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-184	R110, 116, 121, 128, 282	.04	1	3	..	..	1	3	4	13
R111	Plate Side Damping Resistor for T101	Resistor, carbon 4,700 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-175	R111, 117, 122, 129, 137, 165, 177	.04	1	3	..	..	1	4	4	18
R112	Bleeder for 1st counter bias	Resistor, carbon 180,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-213	R112, 138, 242, 284	.04	1	3	..	..	1	2	4	10
R113	1st counter cathode biasing	Resistor, carbon 1,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-62	R113	.02	1	1	..	..	1	1	4	3
R114	1st Counter Count Control	Potentiometer W.W. 10,000 ohms ±10%, 2 W.	-631686-10	....	28	W	K-43J593	R114, 120, 126, 132	.40	1	2	..	..	1	4	4	20
R115	50 u sec. Marker Coupling	Resistor, carbon 30,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-194	R115	.02	1	1	..	..	1	1	4	3
R116	Grid Side Damping for T102	Same as R110															
R117	Plate Side Damping for T102	Same as R111															
R118	Bleeder for 2nd Counter Bias	Resistor, carbon 150,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-88	R118	.02	1	1	..	..	1	1	4	3
R119	2nd Counter Cathode Biasing	Resistor, carbon 8,200 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-73	R119, 125	.02	1	1	..	..	1	1	4	5
R120	2nd Counter Count Control	Same as R114															
R121	Grid Side Damping for T103	Same as R110															
R122	Plate Side Damping for T103	Same as R111															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. an0 Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R123	Bleeder for 3rd Counter Cathode Bias	Resistor, carbon 36,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-196	R123, 226	.04	1	1	..	..	1	1	4	5
R124	Bleeder for 3rd Counter Cathode Bias	Resistor, carbon 39,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-197	R124, 139, 144, 149, 157, 240, 307	.04	1	4	..	..	1	4	4	18
R125	Cathode Biasing	Same as R119															
R126	3rd Counter Count Control	Same as R114															
R127	2500 u sec. Marker Coup.	Resistor,carbon 15,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-76	R127	.01	1	1	..	..	1	1	4	3
R128	Grid Side Damping T104	Same as R110															
R129	Plate Side Damping for T104	Same as R111															
R130	Bleeder for 4th Counter Cathode Bias	Resistor, carbon 39,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-81	R130, 168	.02	1	1	..	..	1	1	4	5
R131	Bleeder for 4th Counter Cathode Bias	Resistor, carbon 33,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-80	R131, 423, 424	.02	1	2	..	..	1	1	4	3
R132	4th Counter Count Control Low Range	Same as R114															
R133	50 Cycle Coupling	Resistor, carbon 22,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-78	R133	.01	1	1	..	..	1	1	4	3
R134	50 Cycle Gate Cathode Leak	Resistor, carbon 91,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-206	R134, 135, 151, 156	.02	1	2	..	..	1	2	4	10
R135	500 u sec. Synch. Gate for Time Corrector	Same as R134															
R136	500 u sec. Sunch. Coupling	Same as R108															

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R137	Balance Control Followed Cathode Load	Same as R111															
R138	Bleeder for Cathode Bias to Time Corrector	Same as R112															
R139	Time Corrector Plate Load, 1st Plate	Same as R124															
R140	Time Corrector Plate to Grid Coupling	Resistor, carbon 390,000 ohms ±5% ½ W.	-63355	....	6	EB	M-31J353-221	R140, 141, 152, 153	.02	1	2	..	..	1	2	4	10
R141	Time Corrector Plate to Grid Coupling	Same as R140															
R143	Time Corrector Bias Control	Potentiometer W.W. 10,000 ohms ±10% 4.W.	-631549	....	23	10	K-43J594	R143	.88	1	1	..	..	1	1	4	5
R144	Time Corrector Plate Load, 2nd Plate	Same as R124															
R145	E.J. Synch. Gate Cathode Return	Resistor, carbon 150,000 ohms ±10% ½ W.	-63360	....	6	EB	M31J353-88	R145, 146, 256	.01	1	2	..	..	1	2	4	10
R146	E.J. Synch. Gate Plate Return	Same as R145															
R147	E.J. B+ Filter.......	Same as R102															
R148	E.-J. Bias Control	Potentiometer W.W. 5,000 ohms ±10% 2 W.	-631689-10	....	28	W	K-44J381	R148	.40	1	1	..	..	1	1	4	5
R149	E.J. Plate Load, 1st Plate	Same as R124															
R150	Bleeder for E.J. Cathode Bias	Resistor, carbon 160,000 ohms ±5% 1 W.	-6329	....	6	GB	M-31J373-212	R150, 253	.04	1	1	..	..	1	1	4	5
R151	E.J. Grid Leak, 1st Grid	Same as R134															
R152	E.J. Plate to Grid Coupling	Same as R140															
R153	E.J. Plate to Grid Coupling	Same as R140															
R154	E.J. Synch. Coupling 1st Grid	Resistor, carbon 33,000 ohms ±10% ½ W.	-63360	....	6	EB	M-31J353-80	R154, 155, 194	.01	1	2	..	..	1	2	4	8

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R155	E.J. Synch. Coupling 2nd Grid	Same as R154															
R156	E.J. Grid Leak 2nd Tube	Same as R134															
R157	E.J. Plate Load, 2nd Plate	Same as R124															
R158	E.J. Coupling to Balance Gain Follower	Resistor, carbon 1.5 Meg. ±10% ½ W.	-63360	....	6	EB	M-31J353-100	R158, 161, 217	.01	1	3	..	..	1	2	4	8
R159	Balance Gain Cathode Load	Resistor, carbon 470,000 ohms ±10% 1 W.	-63288	....	6	GB	M-31J373-94	R159, 163, 234, 310	.02	1	3	..	..	1	3	4	11
R160	Balance Gain Control	Potentiometer, carbon 500,000 ohms ±20%	-631684-20	....	6	J	K-43J720	R160	.40	1	2	..	..	1	1	4	5
R161	E.J. Coupling to Balance Gain Follower	Same as R158															
R162	Reflection Plate Isolation	Resistor 1 Meg. ±10% ½ W.	-63360	....	28		M-31J707-98	R162	.02	..	..	..	..	1	1	4	3
R163	Balance Gain Cathode Load	Same as R159															
R164	Balance Control Follower Grid Leak	Resistor, carbon 2.7 Meg. ±10% ½ W.	-63360	....	6	EB	M-31J353-103	R164, 167, 238	.01	1	2	..	..	1	2	4	8
R165	Balance Control Follower Cathode Load	Same as R111															
R166	Pedestal Coupling	Same as R108															
R167	Grid Leak for Marker —Pedestal Mixer	Same as R164															
R168	Mixer Cathode Bias	Same as R130															
R169	Mixer Cathode Bias	Resistor, carbon 180,000 ohms ±10% 1 W.	-63288	....	6	GB	M-31J373-89	R169, 245, 249, 269	.02	1	2	..	..	1	2	4	10
R170	Test Follower Cathode Load	Resistor, carbon 56,000 ohms ±10% 1 W.	-63288	....	6	GB	M-31J373-83	R170, 189	.02	1	1	..	..	1	1	4	5

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R171	500 MS Marker Coupling	Same as R108															
R172	500 MS Amplifier Grid Leak	Resistor, carbon 56,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-83	R172, 208	.01	1	1	..	..	1	1	4	5
R173	500 MS Amplifier Cathode Bias	Resistor, carbon 4,700 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-70	R173	.01	1	1	..	..	1	1	4	3
R174	500 MS Amplifier Plate Load	Same as R106															
R175	Marker Mixer Grid Leak	Same as R108															
R176	500 MS Marker Coupling	Resistor, carbon 24,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-192	R176	.02	1	1	..	..	1	1	4	3
R177	Marker Mixer Cathode Load	Same as R111															
R178	Marker Mixer Cathode Load	Resistor, carbon 12,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-75	R178	.02	1	1	..	..	1	1	4	3
R179	Bleeder to Marker Mixer Cathode Load	Resistor, carbon 240,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-216	R179, 232	.04	1	1	..	..	1	1	4	5
R180	Trace Separation Mixer Cathode Load	Resistor, carbon 100,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-86	R180, 237	.02	1	1	..	..	1	1	4	5
R181	Trace Shift Amplitude Divider	Same as R104															
R182	Trace Shift Amplitude Control	Potentiometer 2 Meg. ±20%	-631679-20	....	11	35	K-43J589	R182, 218, 221	.28	1	5	..	..	1	3	4	15
R183	Trace Shift Amplitude Divider	Resistor, carbon 1.2 Meg. ±5%, ½ W.	-63355	....	6	EB	M-31J353-233	R183	.02	1	1	..	..	1	1	4	3
R184	Trace Shift Amplitude Divider	Resistor, carbon 1.6 Meg. ±5%, ½ W.	-63355	....	6	EB	M-31J353-236	R184	.02	1	1	..	..	1	1	4	3
R185	Coarse Delay Bias Bleeder	Resistor, carbon 200,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-214	R185, 188, 192, 255, 258, 261	.04	1	3	..	..	1	3	4	15
R186	4th Counter Count Control; Hi Range	Potentiometer W.W. 10,000 ohms ±10%	-631687-10	....	28	W	K-43J595	R186, 202, 252, 270	.40	1	2	..	..	1	4	4	20

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R188	Coarse Delay Bias Bleeder	Same as R185															
R189	Test follower cathode load	Same as R170															
R190	E.J. Cathode Bias	Resistor, carbon 3,900 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-173	R190,R285	.04	1	1	..	..	1	2	4	6
R191	E.J. Coupling to Trace Separation Mixer	Resistor, carbon 82,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-85	R191	.01	1	1	..	..	1	1	4	3
R192	Coarse Delay Bias Bleeder	Same as R185															
R193	Synch. Isolation Coarse Delay Grid	Same as R108															
R194	Synch. Coupling to E.J.	Same as R154															
R195	Coarse Delay Plate Load; 1st Plate	Resistor, carbon 20,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-190	R195, 206, 263	.04	1	2	..	..	1	2	4	8
R196	Coarse Delay Time Constant with C167	Resistor, carbon 3.3 Meg. ±5%, 1 W.	-63291	....	6	GB	M-31J373-243	R196	.04	1	1	..	..	1	1	4	3
R197	Coarse Delay Cathode Bias	Resistor, carbon 12,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-185	R197	.04	1	1	..	..	1	1	4	3
R198	Coarse Delay Plate Load 2nd Plate	Resistor, carbon 10,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-183	R198, 199, 203, 209, 210, 211, 266, 267, 271, 278	.04	1	5	..	..	1	5	4	25
R199	Coarse Delay Plate Load, 2nd Plate	Same as R198															
R200	Coarse Delay B4 Filter	Same as R102															

*American War Standards Number.

Symbol Desig- nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig- nation	G.E. Co. Dwg. and Part No.	All Symbol Desig- nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R201	Fixed Delay Bias Bleeder	Resistor, carbon 220,000 ohms ±5%, 1 W.	–63201	....	6	GB	M-31J373-215	R201, 302	.04	1	2	..	..	1	2	4	6
R202	Fixed Delay Bias Control	Same as R186															
R203	Fixed Delay Bias Bleeder	Same as R198															
R204	Fixed Delay, 1st Grid Isolation	Same as R198															
R205	Synch. Coupling to Fixed Delay	Resistor, carbon 27,000 ohms ±10%, ½ W.	–63360	....	6	EB	M-31J353-79	R205	.01	1	1	..	..	1	1	4	3
R206	Fixed Delay Plate Load, 1st Plate	Same as R195															
R207	Fixed Delay Time Constant with C173	Resistor, carbon 3.9 Meg. ±5%, 1 W.	–63291	....	6	GB	M-31J373-245	R207, 272	.04	1	1	..	..	1	1	4	5
R208	2500 MS Coupling	Same as R172															
R209	Fixed Delay Cathode Bias	Same as R198															
R210	Fixed Delay Plate Load, 2nd Plate	Same as R198															
R211	Fixed Delay Plate Load, 2nd Plate	Same as R198															
R212	"A" Pedestal Synch. Gate Plate Return	Resistor, carbon 330,000 ohms ±10%, ½ W.	–63360	....	6	EB	M-31J353-92	R212, 213, 283	.01	1	2	..	..	1	2	4	8
R213	Fixed Delay Synch. Gate Cathode Leak	Same as R212															
R214	Receiver Gain Control	Resistor, carbon 2,000 ohms 4 W.W.W. Pot. Tap. ±10%	–632028-10	....	23	10	K-43J588	R214	.86	1	1	..	..	1	1	4	5
R215	Cathode Ray Tube Bias Bleeder	Resistor, carbon 330,000 ohms ±10%, ½ W.		....	28	–	M-31J707-92	R215	.02	..	..	..	..	1	1	4	3
R216	C.R.T. Bias Bleeder	Resistor, carbon 330,000 ohms ±10%, 1 W.	–63288	....	6	GB	M-31J373-92	R216, 219	.02	1	1	..	..	1	1	4	5
R217	Deflection Plate Isolation Resis.	Same as R158															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R218	Vert. Cent. Control	Same as R182															
R219	C.R.T. High Voltage Bleeder	Same as R216															
R220	Fixed Delay Synch. Coupling	Same as R108															
R221	Astigmatism Control	Same as R182															
R222	High Voltage Bleeder	Resistor, carbon 330,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-219	R222, 229	.04	1	1	..	..	1	1	4	5
R223	Crystal Buffer Plate Load	Same as R109															
R224	High Voltage Bleeder	Resistor, carbon 470,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-223	R224, 225	.04	1	1	..	..	1	1	4	5
R225	High Voltage Bleeder	Same as R224															
R226	Pedestal Bias Bleeder	Same as R123															
R227	Training Signal Coupling	Resistor, carbon 4.7 Meg. ±10%, ½ W.	-63360	....	6	EB	M-31J353-106	R227, 257	.02	1	1	..	..	1	1	4	5
R228	Restorer Time Constant with C193	Resistor, carbon 2.7 Meg. ±10%, 1 W.	-63288	....	6	GB	M-31J373-105	R228	.02	1	1	..	..	1	1	4	3
R229	High Voltage Bleeder	Same as R222															
R230	Focus Control	Potentiometer, carbon 750,000 ohms ±10%	-631681-10	....	6	J	K-43J591-210	R230	.74	1	2	..	..	1	1	4	5
R231	High Voltage Bleeder	Resistor, carbon 270,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-217	R231, 436	.04	1	2	..	..	1	2	4	6
R232	High Voltage Bleeder	Same as R179															
R233	Intensity Control	Potentiometer, carbon 500,000 ohms ±10%	-631685-10	....	6	J	K-43J719	R233	.29	1	2	..	..	1	1	4	5
R234	Intensity Range Limiter	Same as R159															

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Quant.	Box No.
R235	Pedestal Follower Grid Leak	Resistor, carbon 220,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-90	R235	.01	1	1	..	..	1	1	4	3
R236	Pedestal Buffer Cathode Load	Resistor, carbon 9,100 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-182	R236	.02	1	1	..	..	1	1	4	3
R237	Pedestal Buffer Cathode Load	Same as R180															
R238	Sweep Generator Suppressor Leak	Same as R167															
R239	Sweep Generator Series Screen Resistor	Resistor, carbon 68,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-203	R239	.04	1	1	..	..	1	1	4	3
R240	Sweep Generator Plate Load	Same as R124															
R242	Sweep Generator Grid Leak	Same as R112															
R243	Sweep Voltage Divider	Resistor, carbon 620,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-226	R243	.04	1	1	..	..	1	1	4	3
R244	Sweep Voltage Divider and Sweep Amp. Grid Leak	Resistor, carbon 43,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-198	R244	.02	1	1	..	..	1	1	4	3
R245	B+ Bleeder to Sweep Amp. Cathode	Same as R169															
R246	Sweep #1 Length Control	Potentiometer, carbon 100,000 ohms ±20%	-631682-20	....	28	CS	K-43J592	R246, 247	.29	1	2	..	..	1	2	4	10
R247	Sweep #2 Length Control	Same as R246															
R248	Sweep #3 Length Control	Potentiometer, carbon 50,000 ohms ±20%	-631680-20	....	6	J	K-43J590	R248, 250	.28	1	2	..	..	1	2	4	10
R249	Bleeder to Sweep Amp. Cathode	Same as R169															
R250	Sweep #4 length Control	Same as R248															
R251	Sweep Length Bias Bleeder	Resistor, carbon 3.6 Meg. ±5%, ½ W.	-63355	....	6	EB	M-31J353-244	R251	.02	1	1	..	..	1	1	4	3
R252	Horizontal Centering Control	Same as R186															

*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R253	Sweep Amp. Plate Load	Same as R150															
R254	Sweep Synch. Coupling	Same as R108															
R255	Fine Delay Bias Bleeder	Same as R185															
R256	500 u sec Synch. Coupling to Coarse Delay	Same as R145															
R257	Framing Signal Coupling	Same as R227															
R258	Fine Delay Bias Bleeder	Same as R185															
R259	Fixed Delay Input Gate Plate Return	Resistor, carbon 270,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-91	R259	.01	1	1	..	..	1	1	4	3
R261	Fine Delay Bias Bleeder	Same as R185															
R262	Fine Delay 1st Grid Isolation	Same as R108															
R263	Fine Delay Plate Load 1st Plate	Same as R195															
R264	Fine Delay Time Constant with C199	Resistor, carbon 1.2 Meg. ±5%, 1 W.	-63291	....	6	GB	M-31J373-233	R264, 265	.04	1	1	..	..	1	1	4	5
R265	Fine Delay Time Constant with C199	Same as R264															
R266	Fine Delay Cathode Coupling and Bias	Same as R198															
R267	Fine Delay Plate Load 2nd Plate	Same as R198															
R269	Fine Delay Plate Load 2nd Plate	Same as R169															

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R270	Pedestal Bias Control	Same as R136															
R271	Pedestal D.M.V. Plate Load, 1st Plate	Same as R198															
R272	Pedestal Time Constant	Same as R207															
R273	Pedestal D.M.V. Plate Load, 2nd Plate	Resistor, carbon 2,000 ohms ±5% 1 W.	-63291	....	6	GB	M-31J373-166	R273	.04	1	1	..	..	1	1	4	3
R274	Grid Isolation, 2nd Grid, Pedestal D.M.V.	Resistor, carbon 100,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-207	R274	.02	1	1	..	..	1	1	4	3
R275	Pedestal D.M.V. Cathode Coupling and Bias	Resistor, carbon 6,800 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-179	R275	.04	1	1	..	..	1	1	4	3
R276	Pedestal D.M.V. Plate Load, 2nd Plate	Resistor, carbon 3,600 ±5%, 1 W.	-63291	....	6	GB	M-31J373-172	R276	.04	1	1	..	..	1	1	4	3
R277	Pedestal D.M.V. Grid Isolation 1st Grid	Same as R108															
R278	Fine Delay Plate Load 2nd Plate	Same as R198															
R279	Framing Signal Coup. to 1st Counter	Resistor, carbon 560,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-95	R279	.01	1	1	..	..	1	1	4	3
R280	Pedestal D.M.V. Plate Load, 2nd Plate	Resistor, carbon 4,300 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-174	R280	.04	1	1	..	..	1	1	4	3
R281	Equipment Heater...	Resistor, carbon 700 ohms ±10%, 30 W.	-631540	....	59		K-44J622-1	R281, 439	1.29	1	2	..	..	1	4	4	20
R282	4th Counter Cathode Bias	Same as R110															
R283	Divide Plate Bleeder	Same as R212															
R284	Bleeder to 2nd Counter Cathode	Same as R112															
R285	4th Counter Cathode Bias Low Range	Same as R190															

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*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R301	Series Screen V303 Regulator	Resistor, carbon 2,200 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-66	R301, 324	.01	1	1	..	..	1	1	4	5
R302	Control Tube Plate Load	Same as R201															
R303	Grid Isolation V303 Regulator	Resistor, carbon 8,200 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-73	R303, 305	.01	1	1	..	..	1	1	4	5
R304	Cathode Bias V302 Regulator	Resistor, carbon 47 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-46	R304, 306	.02	1	1	..	..	1	1	4	5
R305	Grid Isolation, V302 Regulator	Same as R303															
R306	Cathode Bias V302 Regulator	Same as R304															
R307	Control Tube Bias Bleeder	Same as R124															
R308	B+ Voltage Set. Control	Potentiometer, W.W. 10,000 ohms ±10%	-631687-10	....	28	W	K-44J379	R308	.45	1	1	..	..	1	1	4	3
R309	Control Tube Bias Bleeder	Resistor, carbon 15,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-187	R309	.04	1	1	..	..	1	1	4	3
R310	Negative High Voltage Filter	Same as R159															
R311	Positive High Voltage Bleeder	Resistor, carbon 3.9 Meg. ±10%, 1 W.	-63288	....	6	GB	M-31J373-105	R311, 312, 313, 314, 315, 316, 317	.02	1	4	..	..	1	4	4	18
R312	High Volt. Bleeder	Same as R311															
R313	High Volt. Bleeder	Same as R311															
R314	High Volt. Bleeder	Same as R311															
R315	High Volt. Bleeder	Same as R311															
R316	High Volt. Bleeder	Same as R311															

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R317	Positive High Voltage Bleeder	Same as R311															
R318	Heater Bias Voltage Divide	Resistor, carbon 270,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-91	R318	.02	1	1	..	..	1	1	4	3
R319	Control Tube Bias Bleeder	Resistor, carbon 5,100 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-176	R319, 320, 325	.04	1	2	..	..	1	2	4	8
R320	Control Tube Bias Bleeder	Same as R319															
R321	Bias Voltage Divider	Resistor, carbon 82,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-205	R321	.02	1	1	..	..	1	1	4	3
R322	Bias Voltage Divider	Resistor, carbon 56,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-201	R322	.02	1	1	..	..	1	1	4	3
R323	Control Tube Plate Load 2nd Plate	Resistor, carbon 430,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-222	R323	.04	1	1	..	..	1	1	4	3
R324	Series Screen Resistor V302 Regulator	Same as R301															
R325	Control Tube Bleeder	Same as R319															
R328	Heater Bias Voltage Divider	Resistor, carbon 390,000 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-93	R328	.02	1	1	..	..	1	1	4	3
R329	B + Voltage Control Bleeder	Resistor, carbon 43,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-198	R329	.04	1	1	..	..	1	1	4	3
R330	Coarse Delay Range Skmt.	Resistor, carbon 2,700 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-169	R330, 336	.04	1	1	..	..	1	1	4	5
R331	Coarse Delay Range Set	Potentiometer, W.W. 10,000 ohms ±10%, 2 W.	-631688-10	RE13A492	23	58	K-43J596	R331, 333, 335, 337	.79	..	..	..	..	1	4	4	20
R332	Coarse Delay Control	Potentiometer W.W. 10,000 ohms ±5%, 4 W.	-631547	RE13A49L	23	10	K43J716	R332	1.02	1	1	..	..	1	1	4	5
R333	Coarse Delay Min. Set Control	Same as R331															
R334	Coarse Delay Bias Bleeder	Resistor, carbon 9,100 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J-373-182	R334	.04	1	1	..	..	1	1	4	5
R335	Fine Delay Range Set	Same as R331															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R336	Fine Delay Control Skmt.	Same as R330															
R337	Fine Delay Min. Set Control	Same as R331															
R338	Fine Delay Control	Potentiometer, carbon 10,000 ohms ±5%, 4 W.	-631548	....	23	37	K-43J715	R338	.92	1	1	..	..	1	1	4	5
R401	Cathode Bias	Resistor, carbon 160 ohms ±5%, ½W.	-63355	....	6	EB	M-31J353-140	R401	.02	1	1	..	..	1	1	4	3
R402	Screen Voltage Dropping	Resistor, carbon 62,000 ohms ±5%, 1 W.	-63201	....	6	GB	M-31J373-202	R402	.04	1	1	..	..	1	1	4	5
R403	Cons. Grid Resistor	Resistor, carbon 18,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-189	R403, 437	.02	1	1	..	..	1	1	4	5
R404	Screen Voltage Dropping	Resistor, carbon 7,500 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-180	R404, 405, 438	.04	1	2	..	..	1	2	4	8
R405	Screen Voltage Dropping	Same as R404															
R406	Plate Decoupling	Resistor, carbon 5,600 ohms ±10%, 1 W.	-63288	....	6	GB	M-31J373-71	R406, 409, 413, 416, 434	.02	1	3	..	..	1	3	4	13
R408	Cathode Resistor	Resistor, carbon 270 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-145	R408, 411	.02	1	2	..	..	1	1	4	5
R409	Plate Decoupling	Same as R406															
R411	Cathode Resistor	Same as R408															
R412	Screen Voltage Dropping	Resistor, carbon 56,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-201	R412	.04	1	1	..	..	1	1	4	3
R413	Plate Decoupling	Same as R406															
R415	Screen Voltage Dropping	Resistor, carbon 47,000 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-199	R415, 435	.04	1	1	..	..	1	1	4	5

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
R416	Plate De-coupling	Same as R406															
R419	Time Constant	Resistor, carbon 240,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-216	R419, 420, 422	.02	1	2	..	..	1	2	4	8
R420	Time Constant	Same as R419															
R421	Parasitic Suppressor	Resistor, carbon 1,000 ohms ±10%, ½ W.	-63360	....	6	EB	M-31J353-62	R421	.01	1	1	..	..	1	1	4	3
R422	Time Constant	Same as R419															
R423	Screen Voltage Dropping	Same as R131															
R424	Screen Voltage Dropping	Same as R131															
R425	Plate Load	Resistor, carbon 3,300 ohms ±5%, 1 W.	-63291	....	6	GB	M-31J373-171	R425, 426, 427, 428, 429, 430	.04	1	3	..	..	1	3	4	15
R426	Plate Load	Same as R425															
R427	Plate Load	Same as R425															
R428	Plate Load	Same as R425															
R429	Plate Load	Same as R425															
R430	Plate Load	Same as R425															
R432	OSC. Grid Leak	Resistor, carbon 22,000 ohms ±5%, ½ W.	-63355	....	6	EB	M-31J353-191	R432	.02	1	1	..	..	1	1	4	3
R434	Plate Decoupling	Same as R406															
R435	Screen Voltage Dropping	Same as R415															
R436	Bleeder	Same as R231															
R437	Bleeder	Same as R403															
R438	Plate Load	Same as R404															
R439	Space Heater	Same as R281															
S101A	Framing	Switch		....	32	COC	K-44J614	S101A, 101B	.57	1	2	..	..	1	1	1	1
S101B	Framing	Same as S101A															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS Equip. Box No.	DAS Equip. Quant.	DAS Tender Box No.	DAS Tender Quant.	DAS-2 Equip. Box No.	DAS-2 Equip. Quant.	DAS-2 Stock Box No.	DAS-2 Stock Quant.
S102A	Receive Calibrate	Switch-2 Sections-4 Positions-3 Circuits	....	RE13A317F	32	Per GE Dwg.	K-44J612	S102A, 102B,102C, 102D	2.20	1	1	..	..	1	1	1	1
S102B	Receive Calibrate	Same as S102A															
S102C	Receive Calibrate	Same as S102A															
S102D	Receive Calibrate	Same as S102A															
S103A	Sweep Speed.	Switch-3 Sections-5 Positions-5 Circuits	....	RE13A317F	32	Per GE Dwg.	M-32J938	S103A, 103B,103C, 103D,103E	3.34	1	1	..	..	1	1	1	1
S103B	Sweep Speed	Same as S103A															
S103C	Sweep Speed	Same as S103A															
S103D	Sweep Speed	Same as S103A															
S103E	Sweep Speed	Same as S103A															
S104	Station Selector	Switch-1 Section, 8 Positions	....	RE13A317F	32	Per GE Dwg.	K-44J611	S104	1.52	1	1	..	..	1	1	1	1
S105	4th Counter Range Selector	Switch	-24213	....	110	20905-ME	K-44J420-3	S105, 301, 302	.45	1	1	1	1	1	2	1	3
S301	Power On-Off	Same as S105															
S302	115V-230V Selector	Same as S105															
S401A	Band Change	Switch-4 Positions, 3 Sections	....	RE13A317F	32	Per GE Dwg.	M-32J594	S401A, 401B,401C	4.40	..	..	..	..	1	1	1	1
S401B	Band Change	Same as S401A															
S401B	Band Change	Same as S401A															
S401C	Band Change	Same as S401A															
S402	Filter Control	Switch-2 Positions	....	....	32	Per GE Dwg.	K-43J905-4	S402	.28	..	..	..	..	1	1	1	1

*American War Standards Number.

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
T101	1st Counter Transformer	Transformer-Osc. Blocking	....	....	137	Per GE Dwg.	K-43J709-G1	T101, 02, 03, 04	3.14	1	2	..	..	1	1	1	4
T102	2nd Counter Transformer	Same as T101															
T103	3rd Counter Transformer	Same as T101															
T104	4th Counter Transformer	Same as T101															
T105	Coarse & Fine Delay Heater Isolation Transformer	Transformer Heater	–301067	RE-13A-553	29	Per GE Dwg.	K-44J610	T105	1.26	1	1	..	..	1	1	2	3
T301	Low Voltage Power Transformer	Transformer (Power) Wind / No. Turns / Wire Size / D.C. Res. (ohms) Prim. 177 .0420 2.09 Sec. #1 1292 .0201 42 #2 10 .0720 .0378 #3 11 .185x.105 .0086 #4 8 .0760 .0296 #5 4 .0571 .0225 Wind / RMS Volts / Amps. / Volts to Grd. Prim. 115/230 50–60 CPS 250 Sec. #1 820/410 1000 #2 6.3 2.8 250 #3 6.9 13.5 250 #4 5.0 3.0 250 #5 2.5 1.75 2000 Primary in two sections. Secondary #1 is center-tapped. Electrostatically shielded. Core and Coil Construction.	–301070	RE-13A-554	137	Per GE Dwg.	K-44J607	T301	23.78	..	..	1	1	1	1	2	3

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION FOR NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Designation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Designation	G.E. Co. Dwg. and Part No.	All Symbol Designation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
T302	High Voltage Power Transformer	High Voltage Transformer Wind Turns Wire Size D.C. Res. (ohms) Prim. 1033 .0126 30 Sec. #1 15400 .0031 10650 #2 26 .0031 .125 #3 65 .0320 .586 Wind RMS Volt Amps. Volts to Grd. Prim. 115 50–60 CPS 250 Sec. #1 1600 .003 2000 #2 2.5 1.75 2000 #2 6.3 0.9 2000 Hermetically sealed construction	–301069	RE-13A-553	137	Per GE Dwg.	K-44J608	T302	10.54	..	..	1	1	1	1	2	3
T401	1st I.F. Transformer	I.F. Transformer, Grid Coil: 169 turns; 29 EC Wire; Approx. 1.82 ohms DC Resistance at 20°C; 1000 cycle Inductance-197 uh Plate Coil: 155 turns; 29 EC Wire; Approx. 1.70 ohms DC Resistance at 20°C; 1000 cycle Inductance 193 uh	....	....	137	Per GE Dwg.	K-44J202-G1	T401	2.57	..	..	1	1	1	1	1	3
T402	2nd I.F. Transformer	I.F. Transformer, Plate Coil: 169 turns; 29 EC Wire; Approx. 1.82 ohms DC Resistance at 20°C; 1000 cycle Inductance 197 uh Grid Coil: 164 turns; 29 EC Wire; Approx. 1.77 ohms DC Resistance at 20°C; 1000 cycle Inductance 218 uh	....	....	137	Per GE Dwg.	K-44J202-G2	T402	2.57	..	..	1	1	1	1	1	3

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
T403	3rd I.F. Transformer	I.F. Transformer, Plate Coil: 164 turns; 29 EC Wire; Approx. 1.77 ohms DC Resistance at 20°C; 1000 cycle Inductance 218 uh Grid Coil: 164 turns; 29 EC Wire; Approx. 1.77 ohms DC Resistance at 20°C; 1000 cycle Inductance 218 uh	....	....	137	Per GE Dwg.	K-44J202-G3	T403	2.56	..	..	1	1	1	1	1	3
T404	4th I.F. Transformer	I.F. Transformer, Plate Coil; 155 turns; 29 EC Wire; Approx. 1.70 ohms DC Resistance at 20°C; 1000 cycle Inductance 193 uh Grid Coil: 155 turns; 29 EC Wire; Approx. 1.70 ohms DC Resistance; 1000 Cycle Inductance 193 uh	....	....	137	Per GE Dwg.	K-44J202-G4	T404	2.79	..	..	1	1	1	1	1	3
V101-1	Crystal Oscillator	Tube 6SL7GT.	–6SL7GT	....	471	–6SL7GT	DL4W269A-221 DL4W270A-121	V101-1, V101-2, 112-1, 112-2, 115-1, 115-2, 116-1, 116-2, 117-1, 117-2, 120-1, 120-2, 304-1, 304-2	.86	2	7	..	..	2	14	..	0
V101-2	10 MS Marker Shaper	Same as V101-1															
V102-1	Crystal Buffer	Tube 6SN7GT	6SN7GT	....	43	6SN7GT	DL4W269A-224	V102-1, 102-2, 105-1, 105-2, 108-1, 108-2, 110-1, 110-2, 111-1, 111-2, 113-1, 113-2, 119-1, 119-2, 123-1, 123-2, 126-1, 126-2, 128-1, 128-2	.80	2	10	..	..	2	20	..	0
V102-2	1st Counter	Same as V102-1	6SN7GT														
V103	1st Counter Gate	Tube 6H6GT	6H6GT	....	54	6H6GT	DL4W269A-229	V103, 104, 106, 109, 118, 121, 122	.73	2	9	..	..	2	14	..	0

*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
V104	2nd Counter Gate	Same as V103															
V105-1	2nd Counter	Same as V102-1															
V105-2	3rd Counter	Same as V102-1															
V106	3rd Counter Gate	Same as V103															
V107	4th Counter Gate	Tube 6H6.............	6H6	....	54	6H6	DL4W269A-228 DL4W211A-116	V107, 127, 406	.73	2	2	..	..	2	6	..	0
V108-1	4th Counter	Same as V102-1															
V108-2	Time Corrector Gate	Same as V102-1															
V109	E.J. Gate	Same as V103															
V110-1	Time Corrector	Same as V102-1															
V110-2	Time Corrector	Same as V102-1															
V111-1	Eccles. Jordan	Same as V102-1															
V111-2	Eccles. Jordan	Same as V102-1															
V112-1	Balance Gain	Same as V101-1															
V112-1	Balance Gain	Same as V101-1															
V113-1	Balance Control	Same as V102-1															
V113-2	Balance Control	Same as V102-1															
V114	Video, 10 μ. sec. Marker, Pedestal Mixer	Tube 6J5GT...........	6J5GT	....	54	6J5GT	DL4W269A-231	V114, 125	.64	2	2	..	..	2	4	..	0
V115-1	C2 Test Follower	Same as V101-1															
V115-2	C1 Test Follower	Same as V101-1															
V116-1	500 MS Amp	Same as V101-1															

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
V116-2	Fixed Delay Input Gate	Part of V116															
V117-1	Marker Mixer	Same as V101-1															
V117-2	Trace Separation Mixer	Part of V117															
V118	Step Feed Back Gate	Same as V103															
V119-1	Coarse Delay Multi-vibrator	Same as V102-1															
V119-2	Fine Delay Multi-vibrator	Part of V119															
V120-1	Fixed Delay Multi-vibrator	Same as V101-1															
V120-2	Fixed Delay Multi-vibrator	Part of V120															
V121	Pedestal Input Gate	Same as V103															
V122	Cathode Ray Tube Blanking Restorer	Same as V103															
V123-1	Sweep Input Gate	Same as V102-1															
V123-2	Sweep Input Gate	Part of V123															
V124	Sweep Generator	Tube 6SJ7	6SJ7	....	54	6SJ7	DL4W269A-230	V124	.52	.	.	..	..	2	2	..	0
V125	Sweep Amplifier	Same as V114															
V126-1	Fine Delay Multi-vibrator	Same as V102-1															
V126-2	Fine Delay Multi-vibrator	Part of V126															
V127	Pedestal Input Gate	Same as V107															
V128-1	Pedestal Generator	Same as V102-1															
V128-2	Pedestal Generator	Part of V-128															
V129	Cathode Ray Tube	Tube 5CP1	5CP1	....	45	5CP1	DL4W269A-233	V129	44.90	2	2	..	..	2	4	..	0
V301	Rectifier	Tube 5U4G	5U4G	....	54	5U4G	DL4W270A-119	V301	.68	2	2	..	..	2	2	..	0

*American War Standards Number.

TABLE II (Continued)
PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig- nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig- nation	G.E. Co. Dwg. and Part No.	All Symbol Desig- nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
V302	Regulator	Tube 6Y6G	6Y6G	....	45	6Y6G	DL4W270A-120	V302, V303	.84	2	2	..	..	2	4	..	0
V303	Regulator	Same as V302															
V304-1	Control	Same as V101-1															
V304-2	Control	Part of V304															
V305	Voltage Regulator	Tube VR150	-38250	....	471	38250	DL4W270A-122	V305	1.19	2	2	..	..	2	2	..	..
V306	High Voltage Rectifier	Tube 2X2 H.V	2X2/879	....	54	2X2/879	DL4W270A-123	V306, V307	1.24	2	2	..	..	2	4	..	..
V307	High Voltage Rectifier	Same as V306															
V401	R.F. Amplifier	Tube 6AC7/1852	-6AC7/1852	....	45	6AC7/1852	DL4W271A-171	V401	1.12	2	2	..	..	2	2	..	0
V402	Osc. Converter	Tube 6SA7	-6SA7	....	45	6SA7	DL4W271A-172	V402	.67	2	2	..	..	2	2	..	0
V403	I.F. Amplifie	Tube 6SK7	-6SK7	....	54	6SK7	DL4W271A-174	V403, V404, V405	.66	2	3	..	..	2	6	..	0
V404	I.F. Amplifier	Same as V403															
V405	I.F. Amplifier	Same as V403															
V406	Demodulator	Same as V107															
V407	Video Amplifier	Tube 6AG7	-6AG7	....	54	6AG7	DL4W271A-175	V407	1.19	2	2	..	..	2	2	..	0
W101	Equipment Ground Bus	Bonding Jumper	....	....	551	C	V46J80	W101	.85	..	..	..	..	1	1	1	4
W301	Power to Receiver	Cable Assembly	....	....	137	....	M-55J335	W301	6.31	1	..	..	..	1	1	3	2
X101	For V101	Tube Socket	-49395	RE-49AA312	117	9857	K-35J305	X101 thru X128 X301 thru X305 X401 thru X407	.09	1	17	..	..	1	21	3	40

*American War Standards Number.

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS				DAS-2			
										Equip.		Tender		Equip.		Stock	
										Box No.	Quant.	Box No.	Quant.	Box No.	Quant.	Box No.	Quant.
X102	For V102	Same as X101															
X103	For V103	Same as X101															
X104	For V104	Same as X101															
X105	For V105	Same as X101															
X106	For V106	Same as X101															
X107	For V107	Same as X101															
X108	For V108	Same as X101															
X109	For V109	Same as X101															
X110	For V110	Same as X101															
X111	For V111	Same as X101															
X112	For V112	Same as X101															
X113	For V113	Same as X101															
X114	For V114	Same as X101															
X115	For V115	Same as X101															
X116	For V116	Same as X101															
X117	For V117	Same as X101															
X118	For V118	Same as X101															
X119	For V119	Same as X101															
X120	For V120	Same as X101															
X121	For V121	Same as X101															
X122	For V122	Same as X101															
X123	For V123	Same as X101															
X124	For V124	Same as X101															
X125	For V125	Same as X101															
X126	For V126	Same as X101															
X127	For V127	Same as X101															

*American War Standards Number.

TABLE II (Continued)

PARTS AND SPARE PARTS LIST BY SYMBOL DESIGNATION
FOR
NAVY MODELS DAS AND DAS-2 EQUIPMENTS

Symbol Desig-nation	Function	Description	Navy Type No.	Navy Dwg. or Spec. No.	Mfg.	Mfg. Desig-nation	G.E. Co. Dwg. and Part No.	All Symbol Desig-nation	Unit Price	DAS Equip. Box No.	DAS Equip. Quant.	DAS Tender Box No.	DAS Tender Quant.	DAS-2 Equip. Box No.	DAS-2 Equip. Quant.	DAS-2 Stock Box No.	DAS-2 Stock Quant.
X128	For V128	Same as X101															
X129	For V129	Tube Socket (Diheptal)	–49392	....	45	9952-C	K-44J925	X129	1.08	1	1	1	1	1	1	1	1
X130	For Y101	Socket (Crystal)	–49436	....	45	....	K-44J802	X130	.74	1	1	..	..	1	1	3	1
X301	For V301	Same as X101															
X302	For V302	Same as X101															
X303	For V303	Same as X101															
X304	For V304	Same as X101															
X305	For V305	Same as X101															
X306	For V306	Tube Socket	–49400	....	107	77A-4TM	K-35J729	X306,X307	.52	1	1	..	..	1	1	1	2
X307	For V307	Same as X306															
X401	For V401	Same as X101															
X402	For V402	Same as X101															
X403	For V403	Same as X101															
X404	For V404	Same as X101															
X405	For V405	Same as X101															
X406	For V406	Same as X101															
X407	For V407	Same as X101															
Y101	100 KC Crystal	Crystal	–40059	....	45	VC-5KS	K-44J617	Y101	37.36	2	1	..	..	1	1	1	1

*American War Standards Number.

TABLE III
LIST OF MANUFACTURERS

VENDOR NUMBER	VENDOR PREFIX	MANUFACTURER	ADDRESS
1	CMA	P. R. Mallory and Co., Inc.	1941 Thomas Street, Indianapolis, Indiana.
6	CBZ	Allen-Bradley Co.	118 W. Greenfield Ave., Milwaukee, Wisconsin.
7	CD	Cornell-Dubilier Corp.	1000 Hamilton Blvd., So. Plainfield, New Jersey.
8	CBN	Central Radio Laboratory	900 E. Keefe Ave., Milwaukee, Wisconsin.
10	CG	General Electric Company	100 Woodlawn Avenue, Pittsfield, Massachusetts
11		Chicago Telephone Supply	Elkhart, Indiana
16	CFW	Sickles Manufacturing Co.	Springfield, Massachusetts
17	CMR	Micamold Radio Manufacturing Co.	1087-1095 Flushing Ave., Brooklyn, New York.
23	CMC	Clarostat Manufacturing Co., Inc.	285-287 North 6th Street, Brooklyn, New York.
24	CMF	Electro Motive Corp.	Willimantic, Connecticut.
27	CSL	Solar Manufacturing Co.	588 Avenue "A" Bayonne, New Jersey.
28	CIR	International Resistance Corp.	401 N. Broad Street, Philadelphia, Pa.
29	CTG	General Transformer Corp.	1250 W. Van Buren St., Chicago, Illinois.
31	CBV	John E. Fast and Company	Crawford at Barry, Chicago, Illinois.
32	COC	Oak Manufacturing Co.	1200 N. Claybourne Street, Chicago, Illinois.
43	CRP	Raytheon Production Corp.	55 Chapel Street, Newton, Massachusetts.
45	CRC	R.C.A. (Tube Division)	Harrison, New Jersey.
54	CKR	Ken Rad Tube and Lamp Works	Owensboro, Kentucky.
59	CAO	Ward Leonard Electric Co.	6 South Street, Mt. Vernon, New York.
102		Allen Manufacturing Co.	133 Sheldon Street, Hartford, Connecticut.
106	CAS	American Lava Corp.	Cherokee Blvd. & Mfgr's Rd., Chattanooga, Tennessee.
107	CPH	American Phenolic Corp.	1250 W. Van Buren Street, Chicago, Illinois.
108	CMH	American Radio Hardware Co., Inc.	476 Broadway, New York, N. Y.
110	CHH	Arrow, Hart and Hegeman Electric Co.	102 Rawthorne Street, Hartford, Connecticut.
117	CMC	Cinch Manufacturing Co.	2339 W. Van Buren Street, Chicago, Illinois.
137	CG	General Electric Co.	1285 Boston Avenue, Bridgeport, Connecticut.
138	CG	General Electric Co.	1635 Broadway, Fort Wayne, Indiana.
153	CLF	Littlefuse, Inc.	4765 Ravenswood Avenue, Chicago, Illinois.
158		James Millen Mfg. Co.	150 Exchange St., Malden, Mass.
160		Monowatt Electric Corp.	66 Bissell Street, Providence, Rhode Island.
200		Dunbar Brothers	76 South Street, Bristol, Connecticut.
329	CAN	Sangamo Electric Co.	1935 Funk Street, Springfield, Illinois.
461	CRV	R.C.A. Manufacturing Co., Inc.	Camden, New Jersey.
467		Teckna Plastics	788 Union Street, Brooklyn, New York.
471	CHS	Sylvania Electric Products, Inc.	Emporium, Pennsylvania.
483	CNB	Noma Electric Corp.	55 W. 13th Street, New York, N. Y.

For color codes of resistors and capacitors, see pages 5-29.

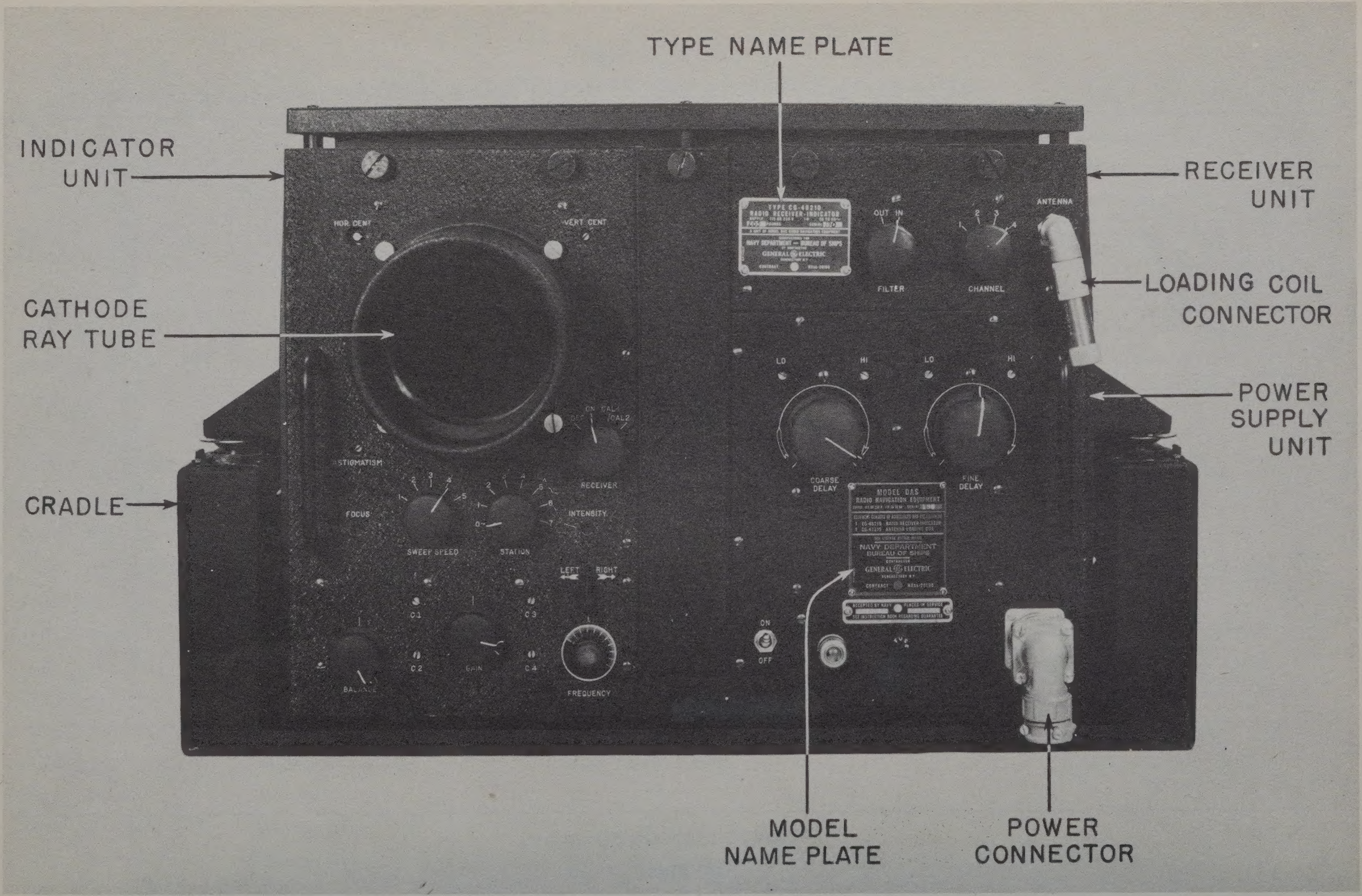

TYPE NAME PLATE
INDICATOR UNIT
RECEIVER UNIT
LOADING COIL CONNECTOR
CATHODE RAY TUBE
POWER SUPPLY UNIT
CRADLE
MODEL NAME PLATE
POWER CONNECTOR
HOR CENT
VERT CENT
ANTENNA
OUT IN
FILTER
CHANNEL
LO
HI
COARSE DELAY
FINE DELAY
ASTIGMATISM
FOCUS
SWEEP SPEED
STATION
RECEIVER
INTENSITY
LEFT
RIGHT
C-1
C-2
C-3
C-4
GAIN
BALANCE
FREQUENCY
ON
OFF

Figure 7-1—Model DAS Receiver-Indicator Unit, Navy Type CG-46210, Front Panel

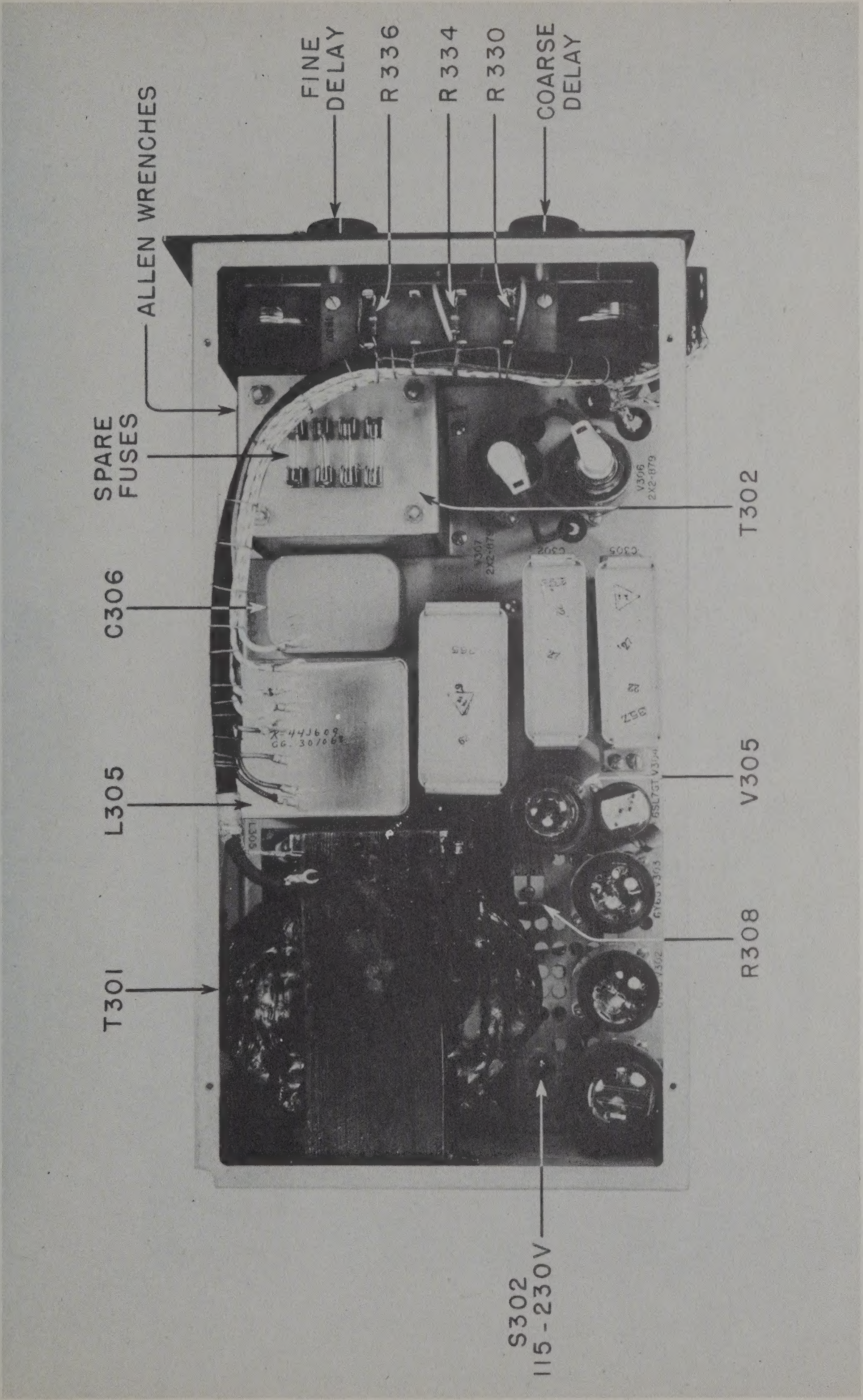

ALLEN WRENCHES
SPARE FUSES
C306
L305
T301
S302
115-230V
FINE DELAY
R336
R334
R330
COARSE DELAY
T302
V305
R308

Figure 7-2—Power Supply Unit, Top View

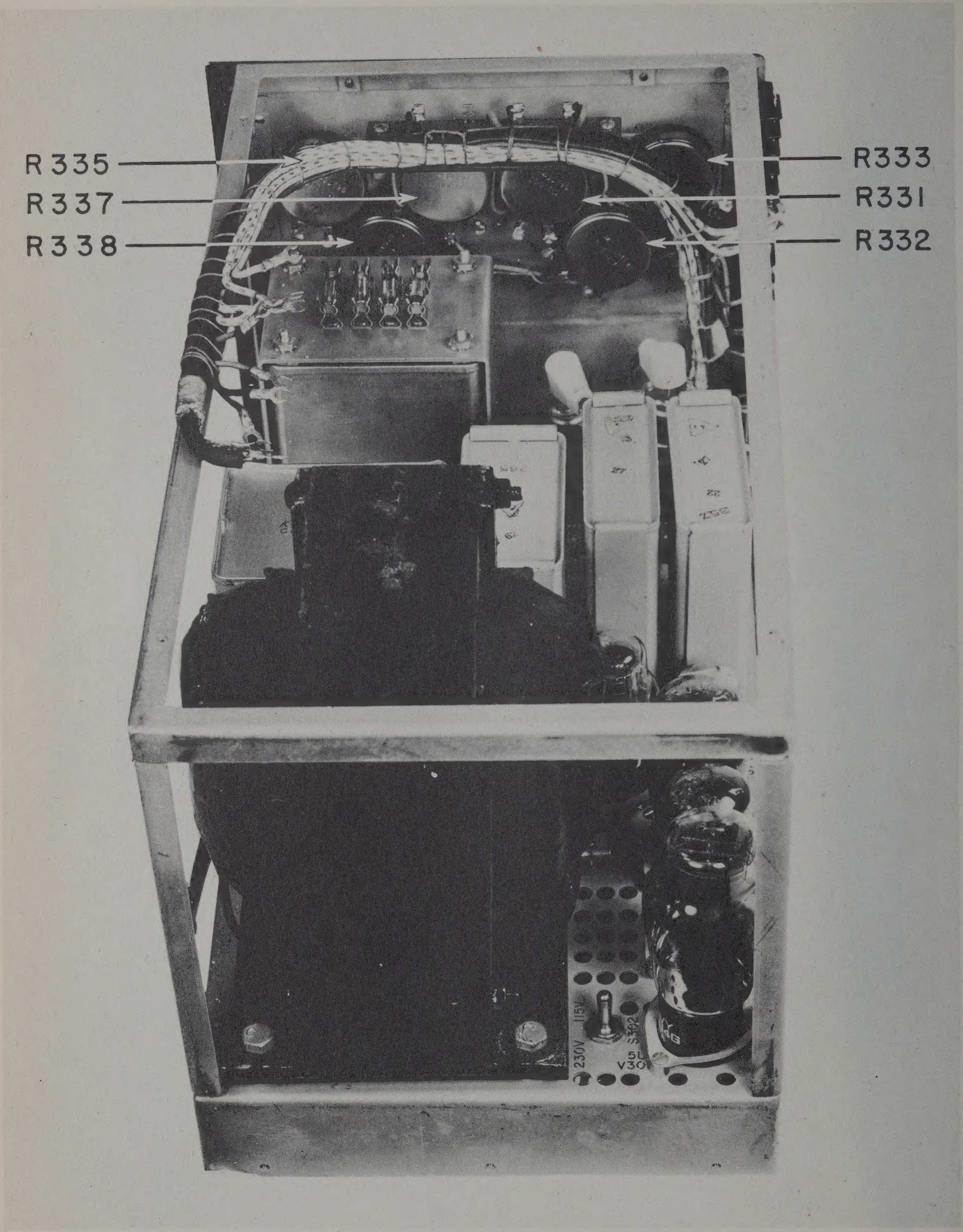

R335
R337
R338
R333
R331
R332
115V
230V
S302
5U
V30

Figure 7-3—Power Supply Unit, Rear View

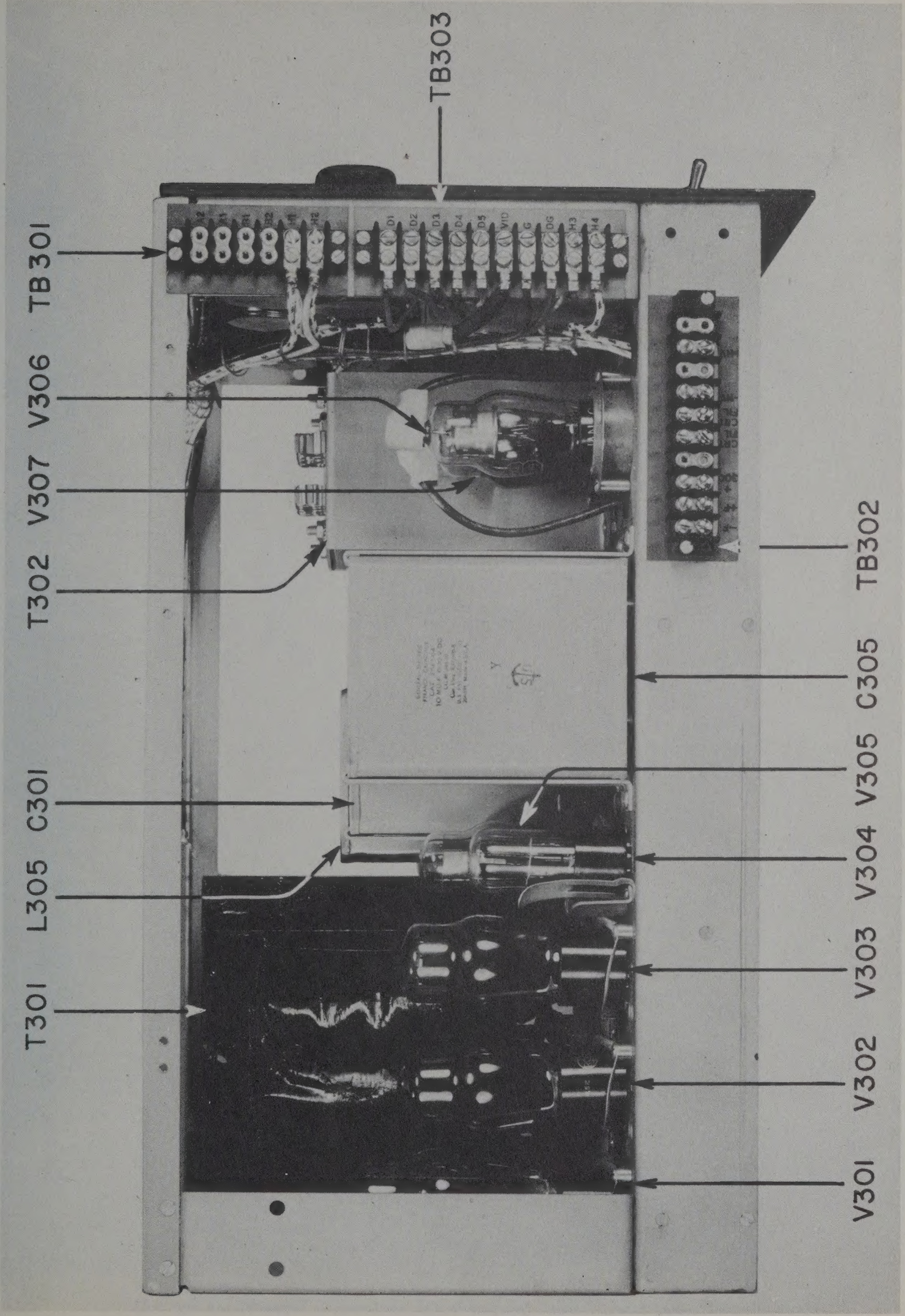

TB301
V306
V307
T302
C301
L305
T301
TB303
TB302
C305
V305
V304
V303
V302
V301

Figure 7-4—Power Supply Unit, Left Side View

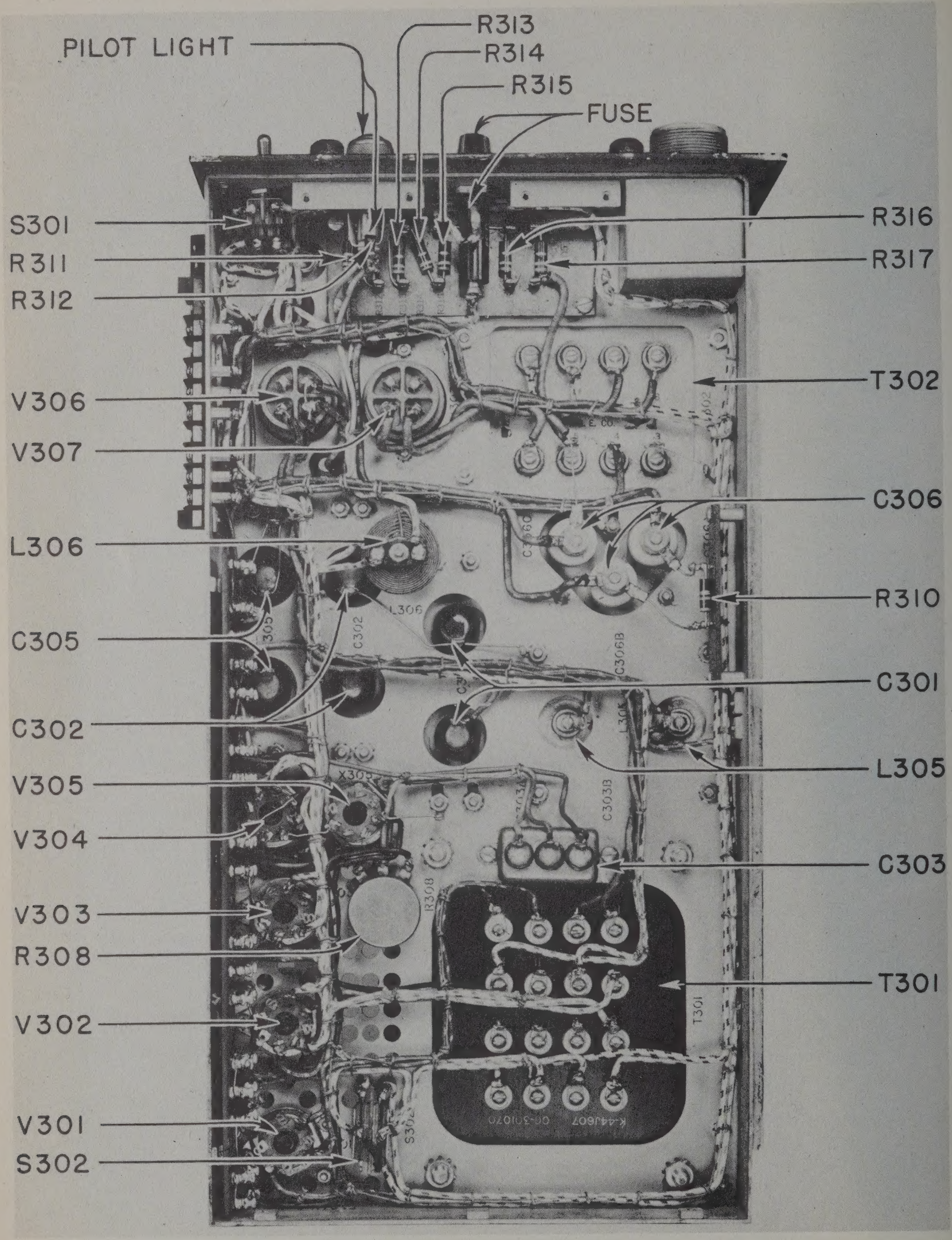

PILOT LIGHT
R313
R314
R315
FUSE
S301
R311
R312
R316
R317
T302
V306
V307
C306
L306
R310
C305
C301
C302
L305
V305
V304
C303
V303
R308
T301
V302
V301
S302

Figure 7-5—Power Supply Unit, Bottom View with Cover Plate Removed

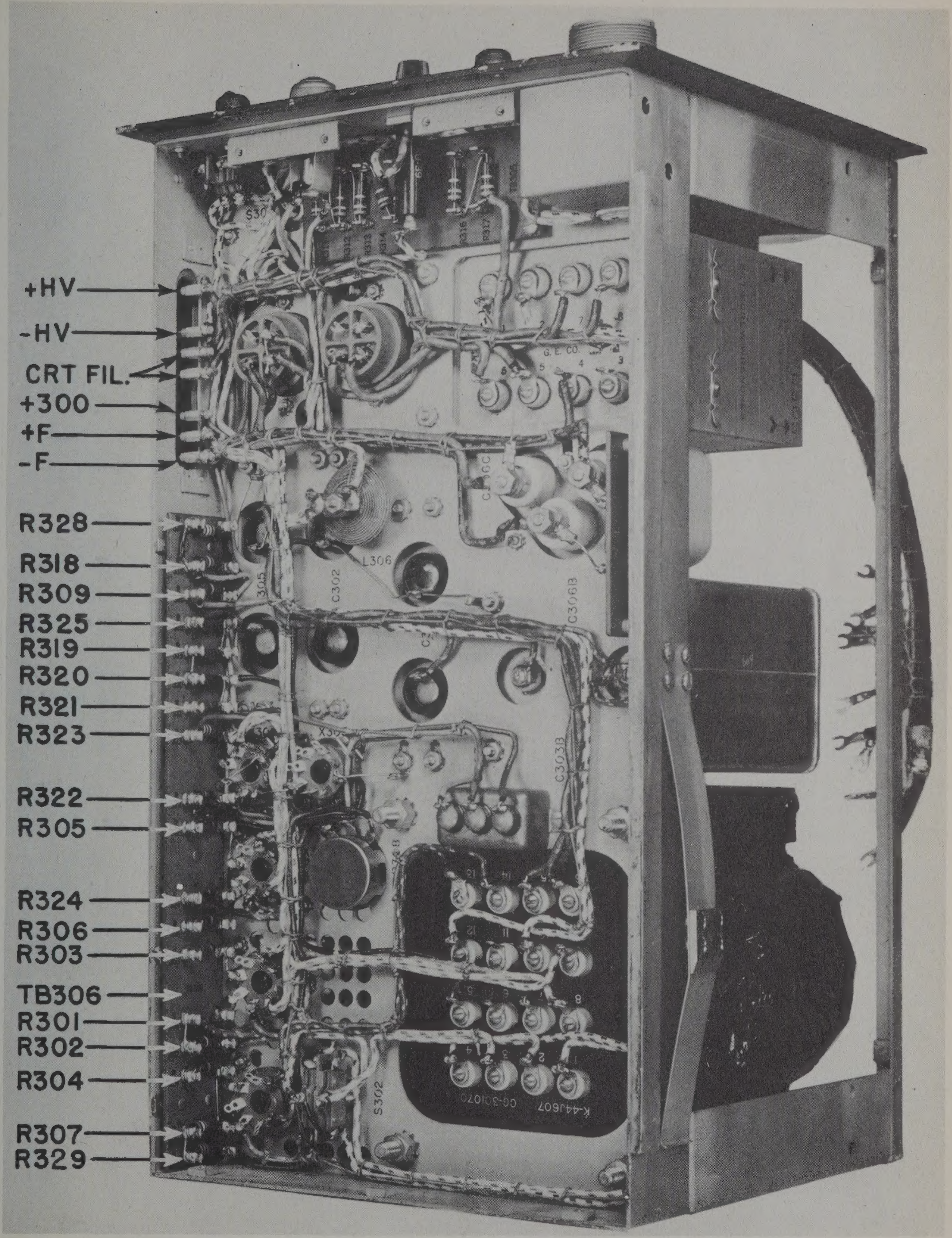

+HV
-HV
CRT FIL.
+300
+F
-F
R328
R318
R309
R325
R319
R320
R321
R323
R322
R305
R324
R306
R303
TB306
R301
R302
R304
R307
R329
L306
C302
C306B
C303B
S302
G. E. CO.

Figure 7-6—Power Supply Unit, Bottom-Right View, with Cover Plate Removed

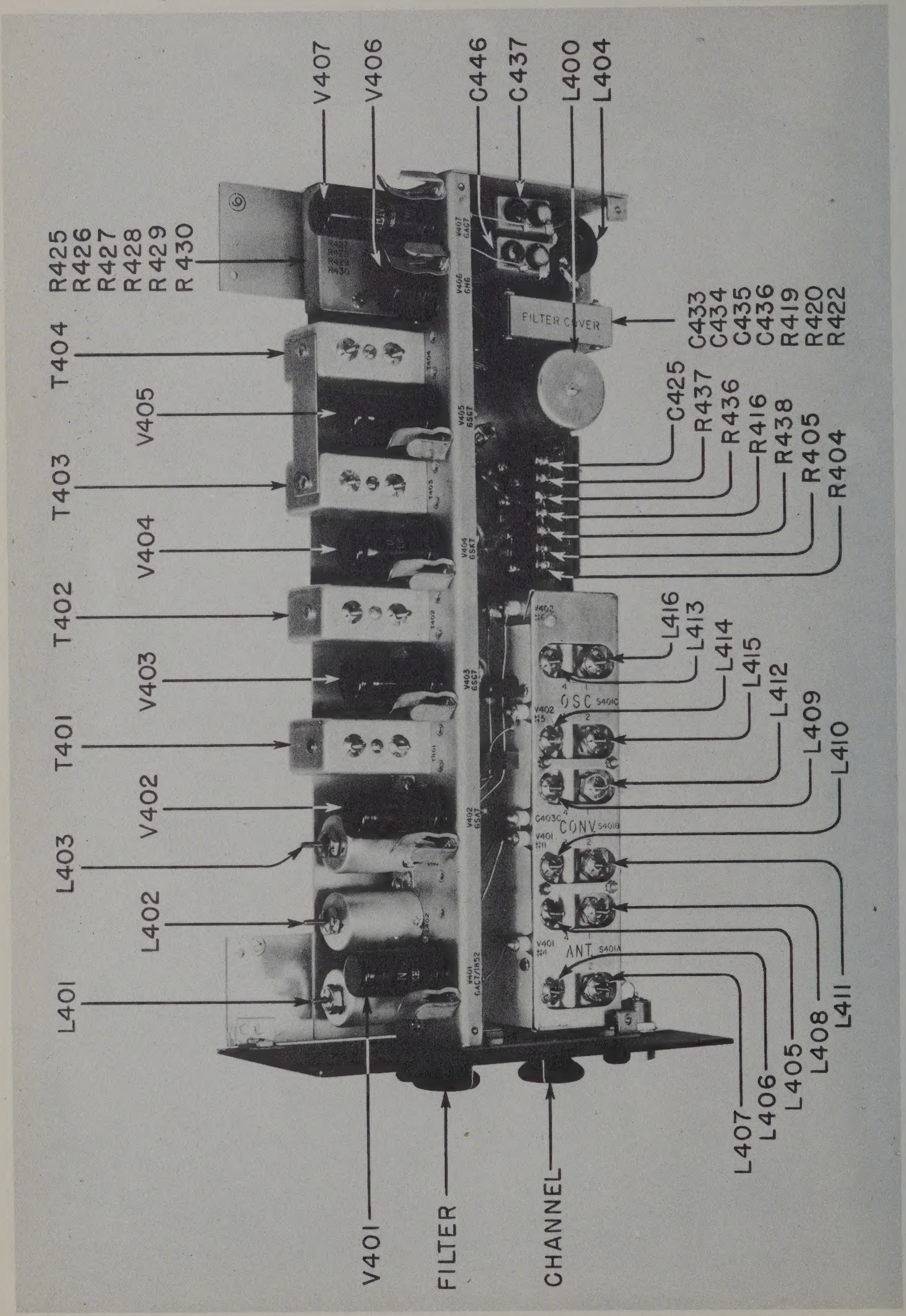

V407
V406
C446
C437
L400
L404
R425
R426
R427
R428
R429
R430
T404
V405
T403
V404
T402
V403
T401
V402
L403
L402
L401
FILTER COVER
C433
C434
C435
C436
R419
R420
R422
C425
R437
R436
R416
R438
R405
R404
L416
L413
L414
L415
L412
L409
L410
OSC
CONV.
ANT.
L411
L408
L405
L406
L407
V401
FILTER
CHANNEL

Figure 7-7—Receiver Unit, Top-Left View, with Cover Shield Removed

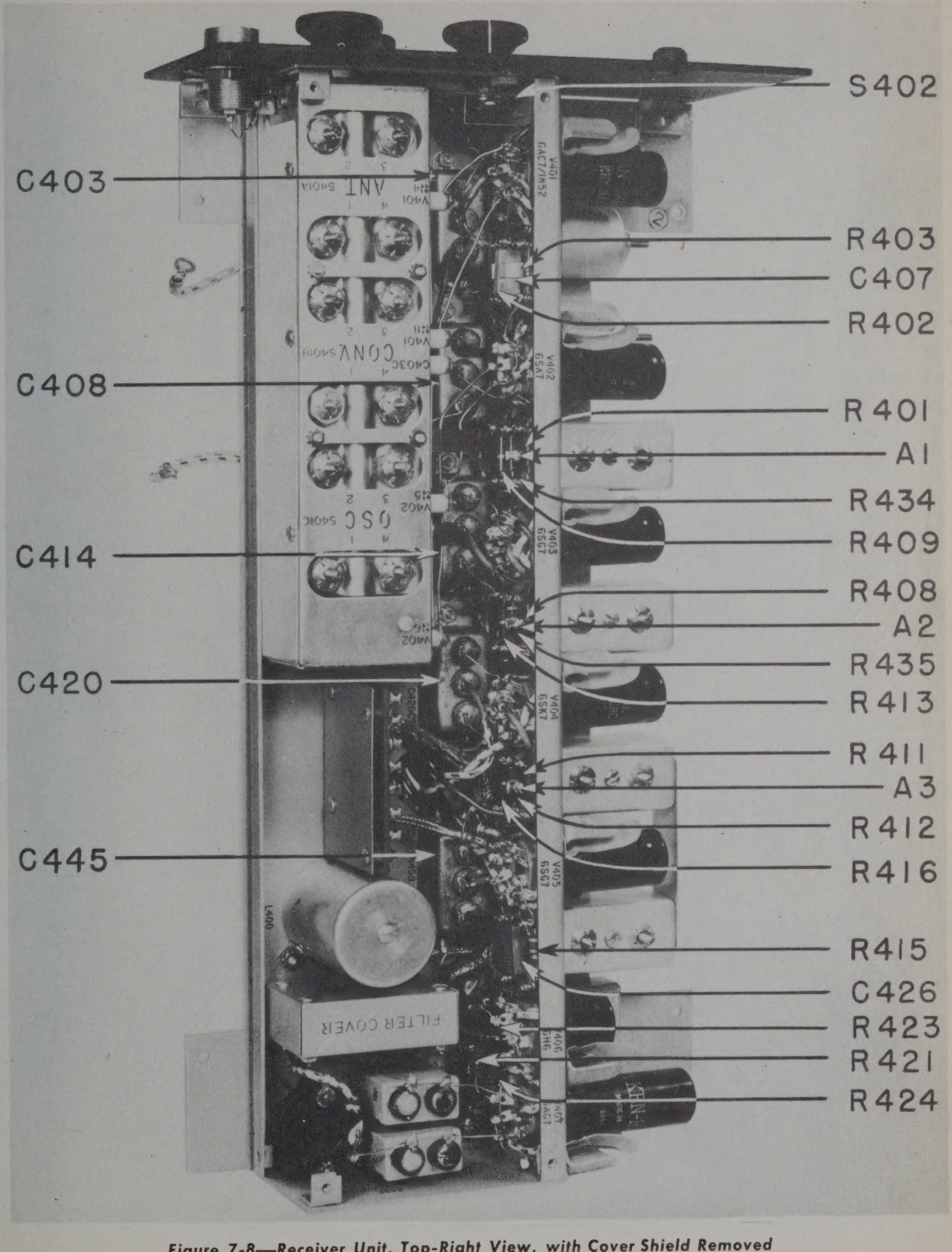

S402
C403
R403
C407
R402
C408
R401
A1
R434
R409
C414
R408
A2
C420
R435
R413
R411
A3
R412
C445
R416
R415
C426
R423
R421
R424
ANT
CONV
OSC
FILTER COVER
V401 6AC7/1852
V402 6SA7
V403 6SG7
V404 6SK7
V405 6SG7
V406 6H6
L400

Figure 7-8—Receiver Unit, Top-Right View, with Cover Shield Removed

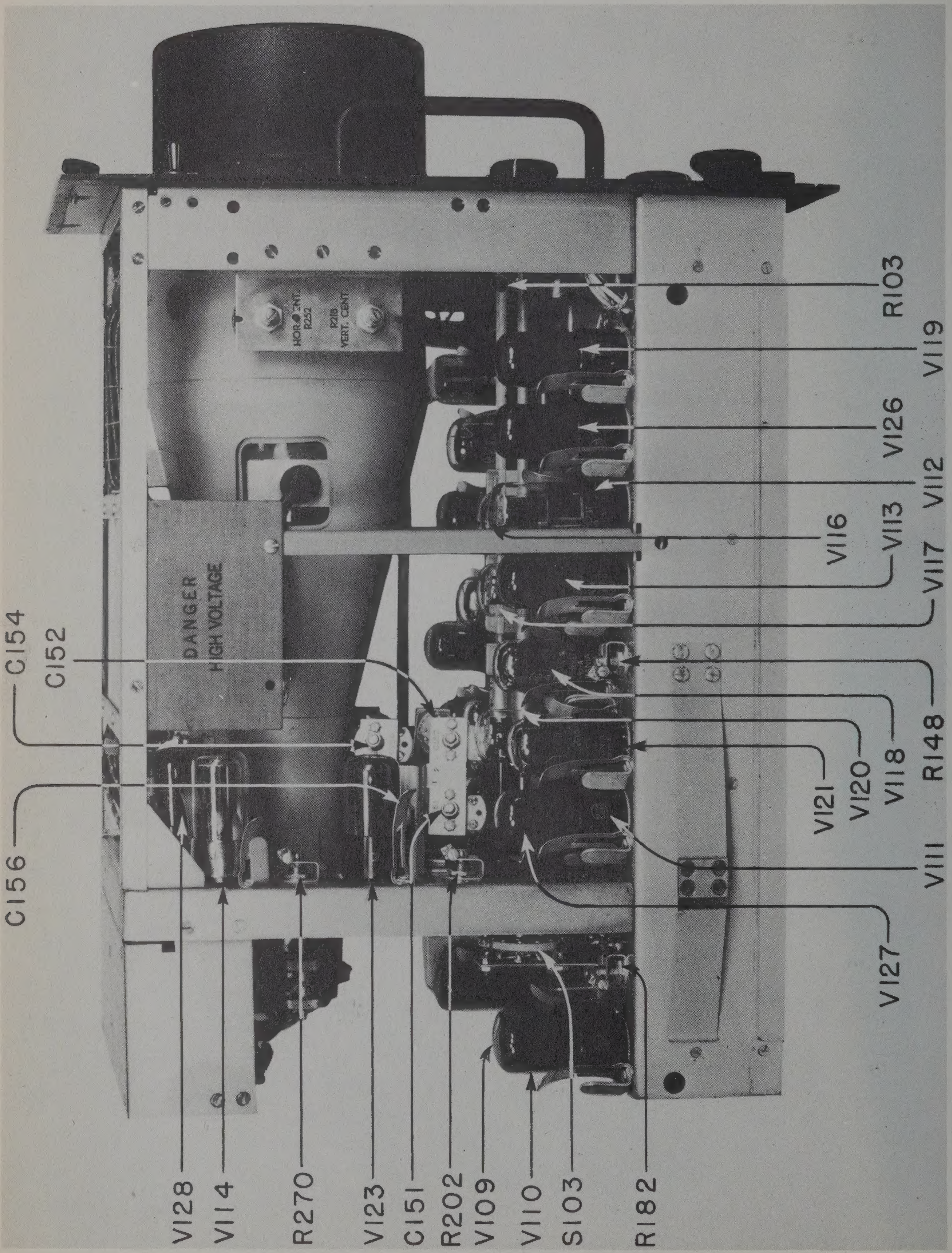

C156
C154
C152
DANGER
HIGH VOLTAGE
HOR. CENT.
R252
R218
VERT. CENT.
R103
V119
V126
V112
V113
V116
V117
R148
V118
V120
V121
V111
V127
V128
V114
R270
V123
C151
R202
V109
V110
S103
R182

Figure 7-9—Indicator Unit, Left Side View

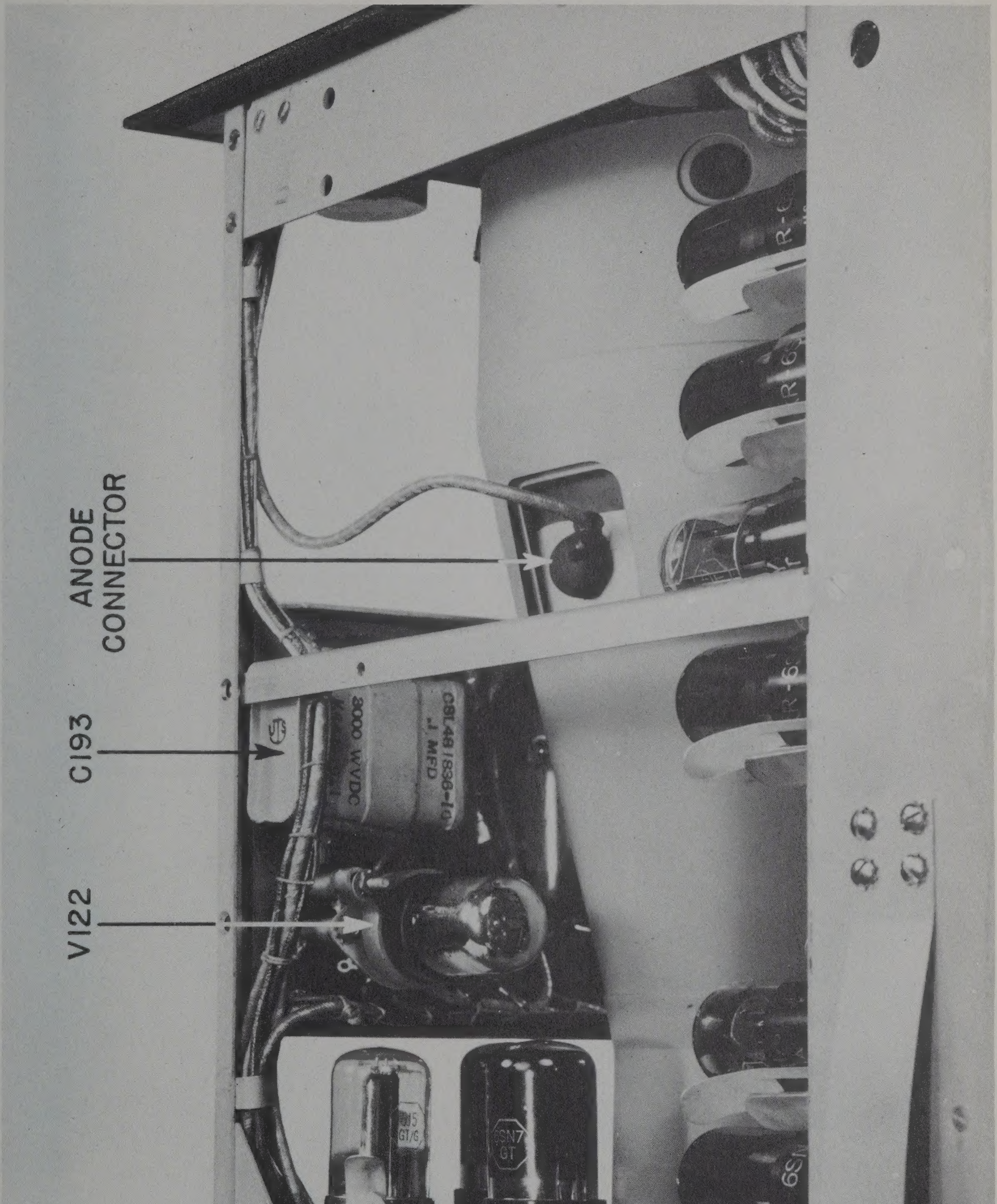

ANODE CONNECTOR
C193
V122

Figure 7-10—Indicator Unit, Left Side View, Showing High Voltage Components

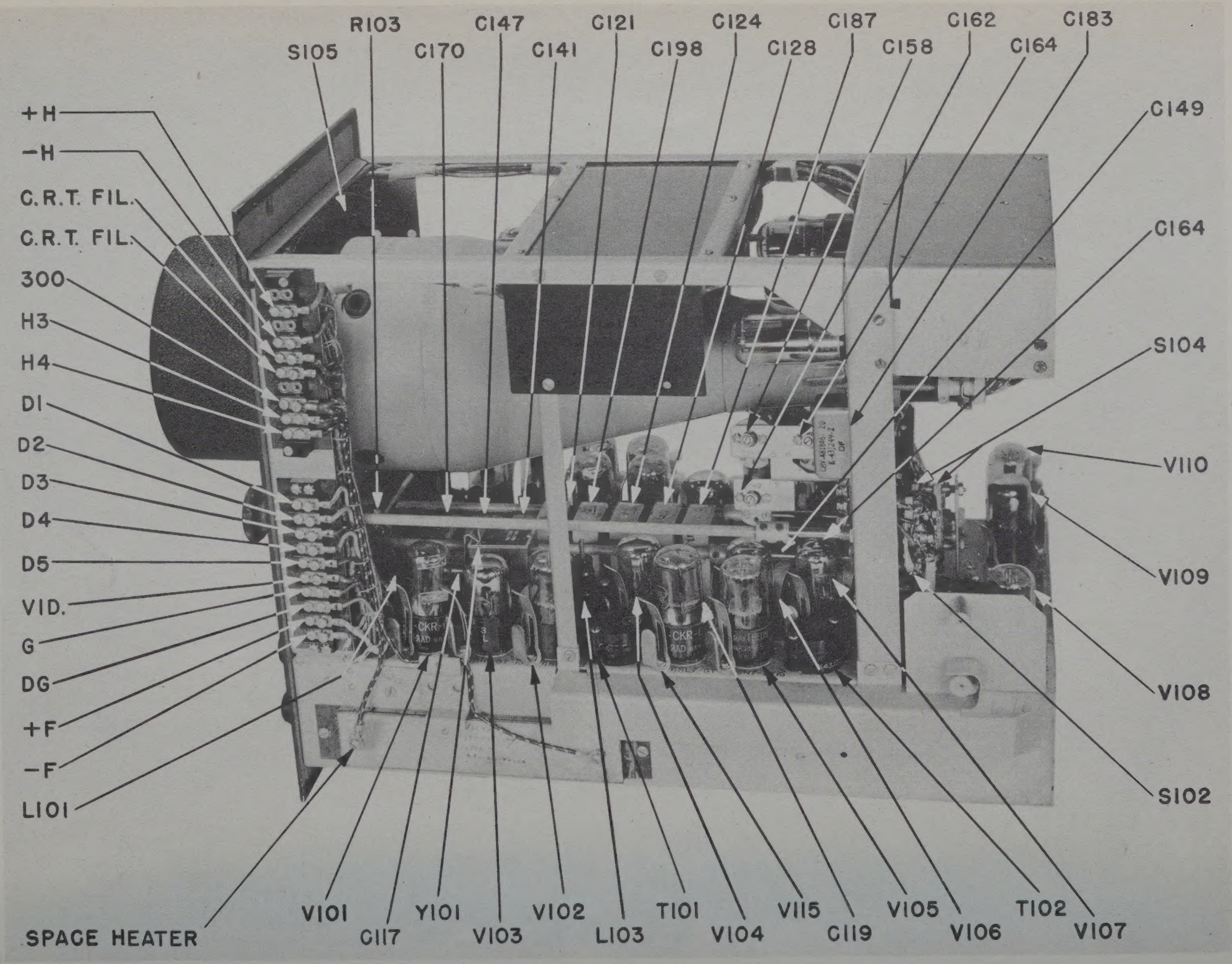

S105
R103
C170
C147
C141
C121
C198
C124
C128
C187
C158
C162
C164
C183
C149
C164
S104
V110
V109
V108
S102
+H
-H
C.R.T. FIL.
C.R.T. FIL.
300
H3
H4
D1
D2
D3
D4
D5
VID.
G
DG
+F
-F
L101
SPACE HEATER
V101
C117
Y101
V103
V102
L103
T101
V104
V115
C119
V105
V106
T102
V107

Figure 7-11—Indicator Unit, Right Side View

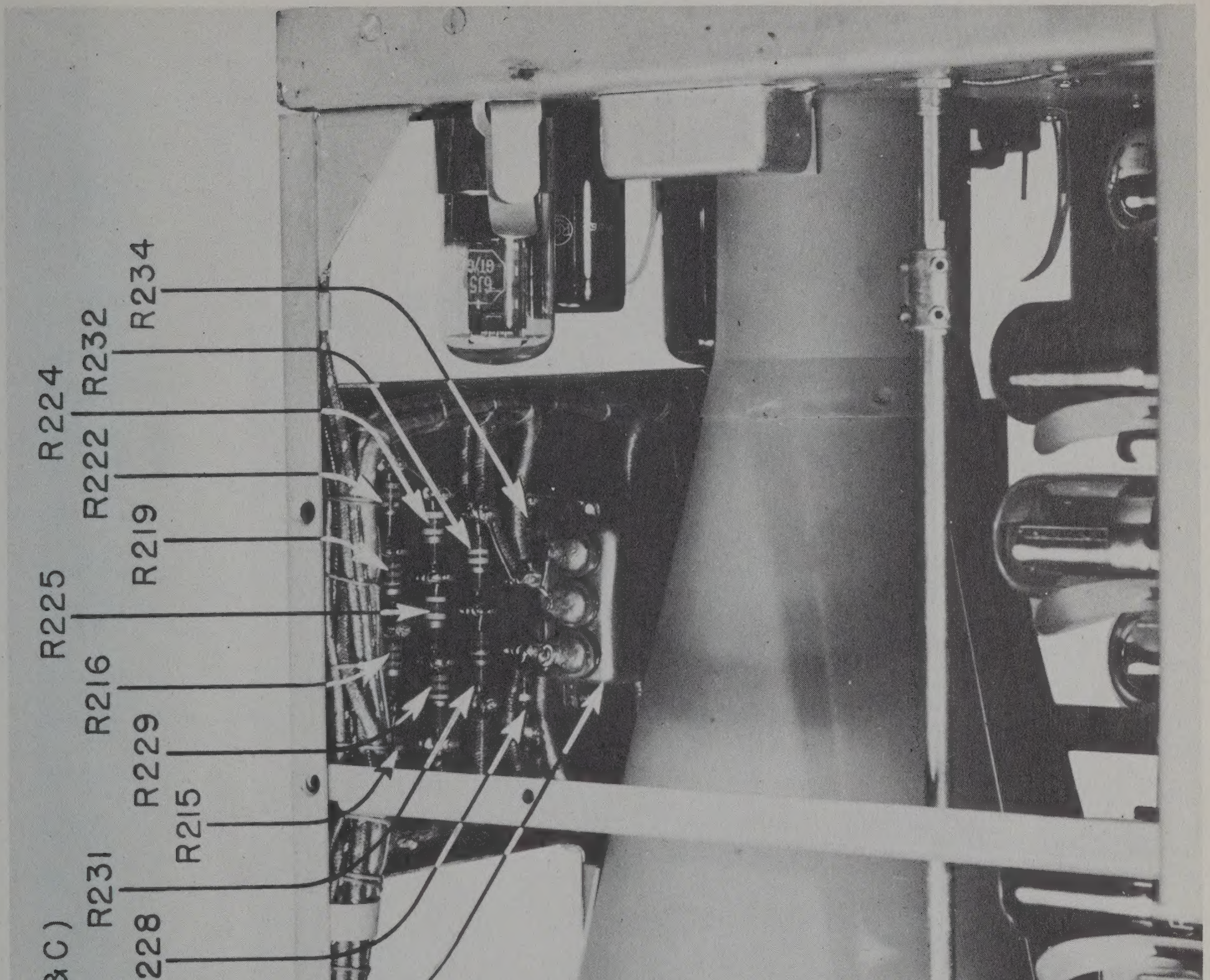

C178 (A,B&C)
R228
R231
R215
R229
R216
R225
R219
R222
R224
R232
R234

Figure 7-12—Indicator Unit, Right Side View, Showing High Voltage Circuits

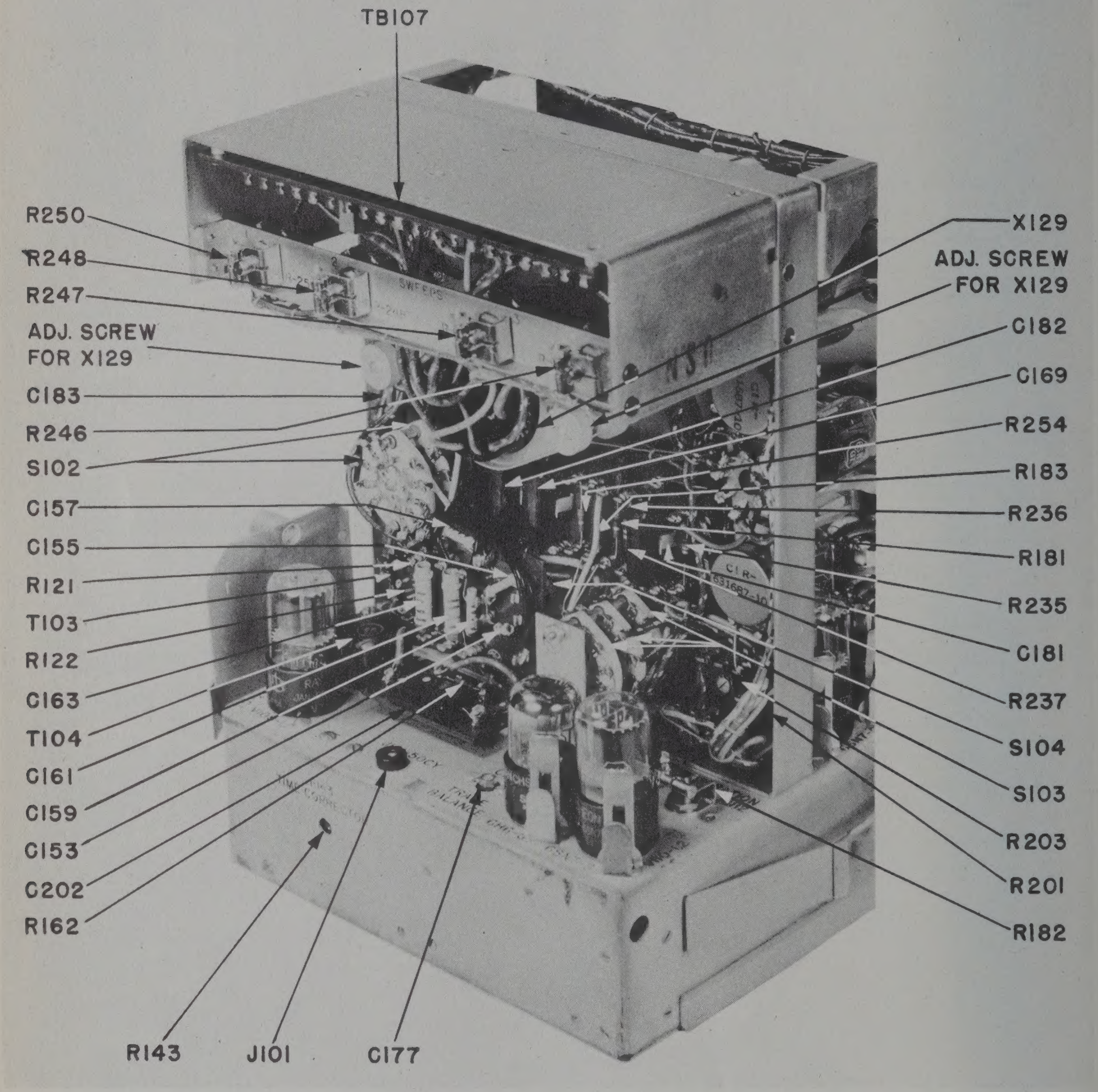

TB107
R250
R248
R247
ADJ. SCREW FOR X129
C183
R246
S102
C157
C155
R121
T103
R122
C163
T104
C161
C159
C153
C202
R162
R143
J101
C177
X129
ADJ. SCREW FOR X129
C182
C169
R254
R183
R236
R181
R235
C181
R237
S104
S103
R203
R201
R182

Figure 7-13—Indicator Unit, Rear View of Vertical Chassis

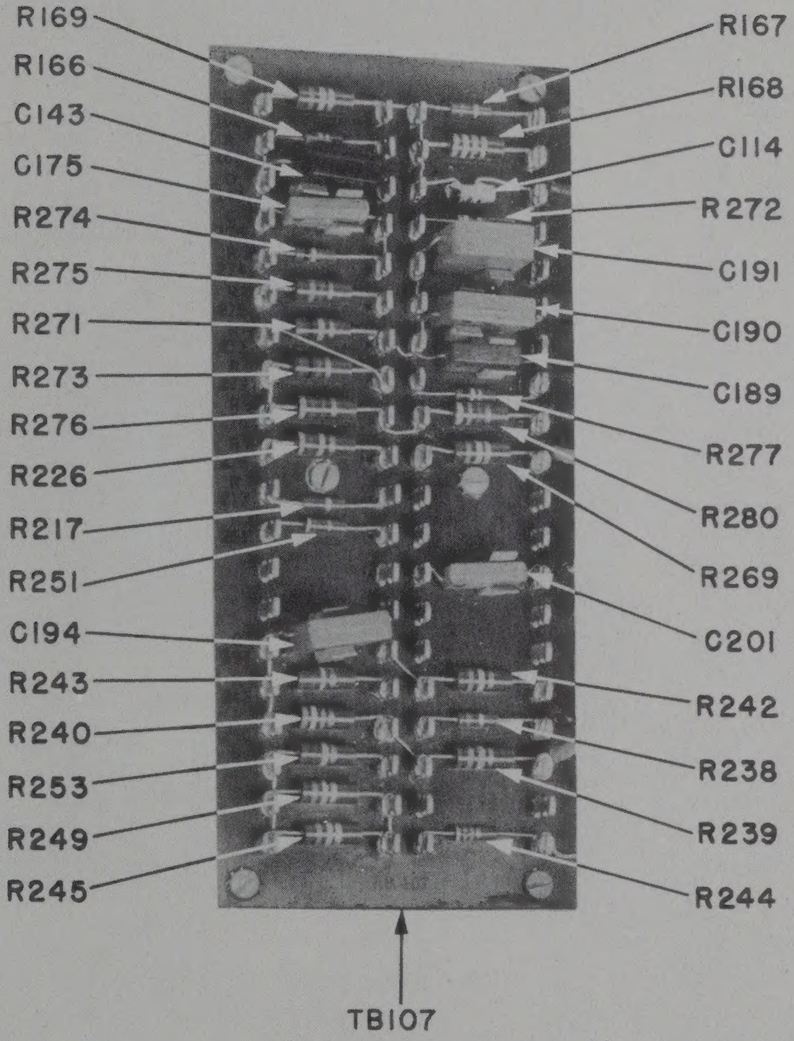

R169
R166
C143
C175
R274
R275
R271
R273
R276
R226
R217
R251
C194
R243
R240
R253
R249
R245
R167
R168
C114
R272
C191
C190
C189
R277
R280
R269
C201
R242
R238
R239
R244
TB107

Figure 7-14—Indicator Unit Terminal Board TB107

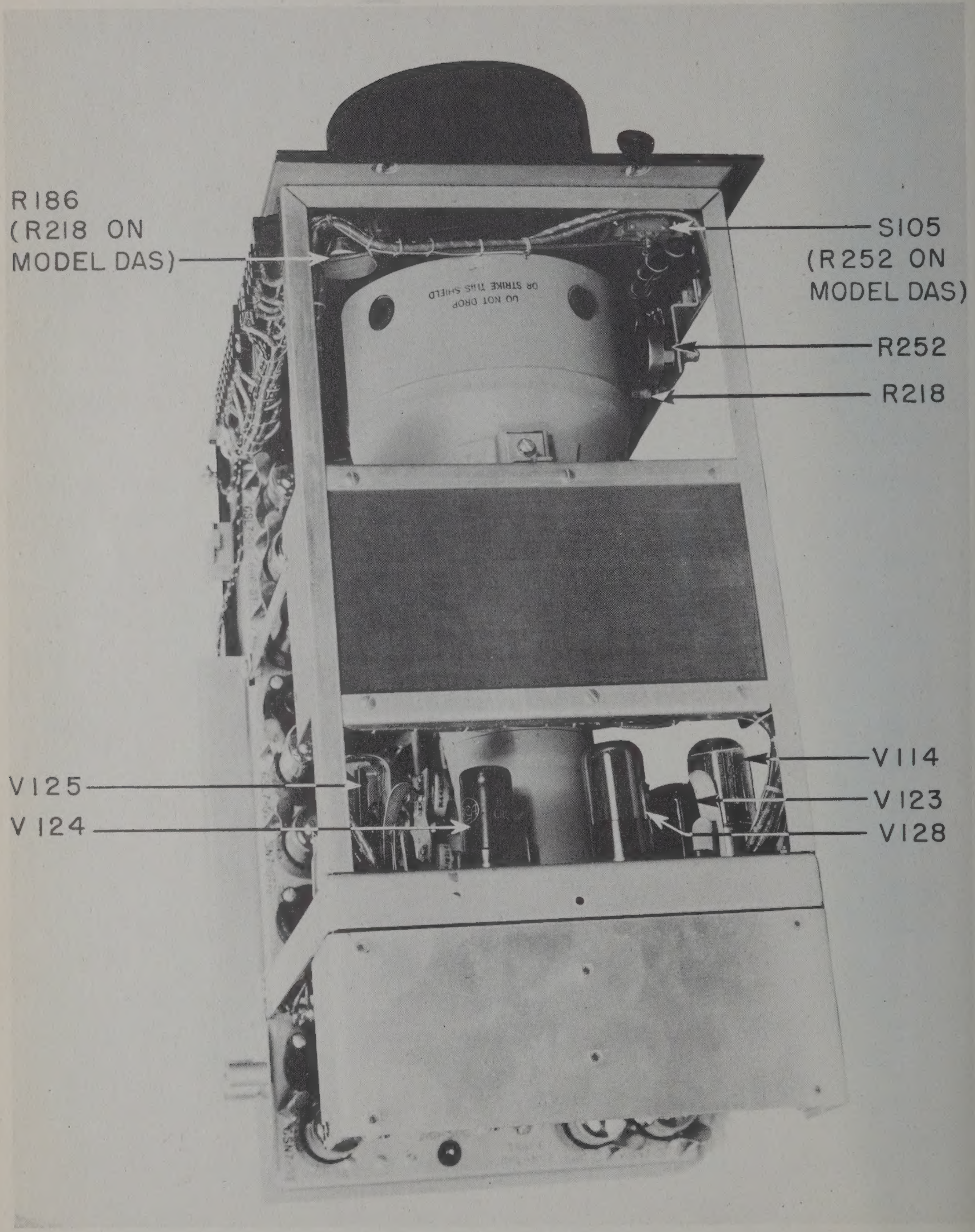

R186
(R218 ON
MODEL DAS)
S105
(R252 ON
MODEL DAS)
R252
R218
DO NOT DROP
OR STRIKE THIS SHIELD
V114
V123
V128
V125
V124

Figure 7-15—Indicator Unit, Top View

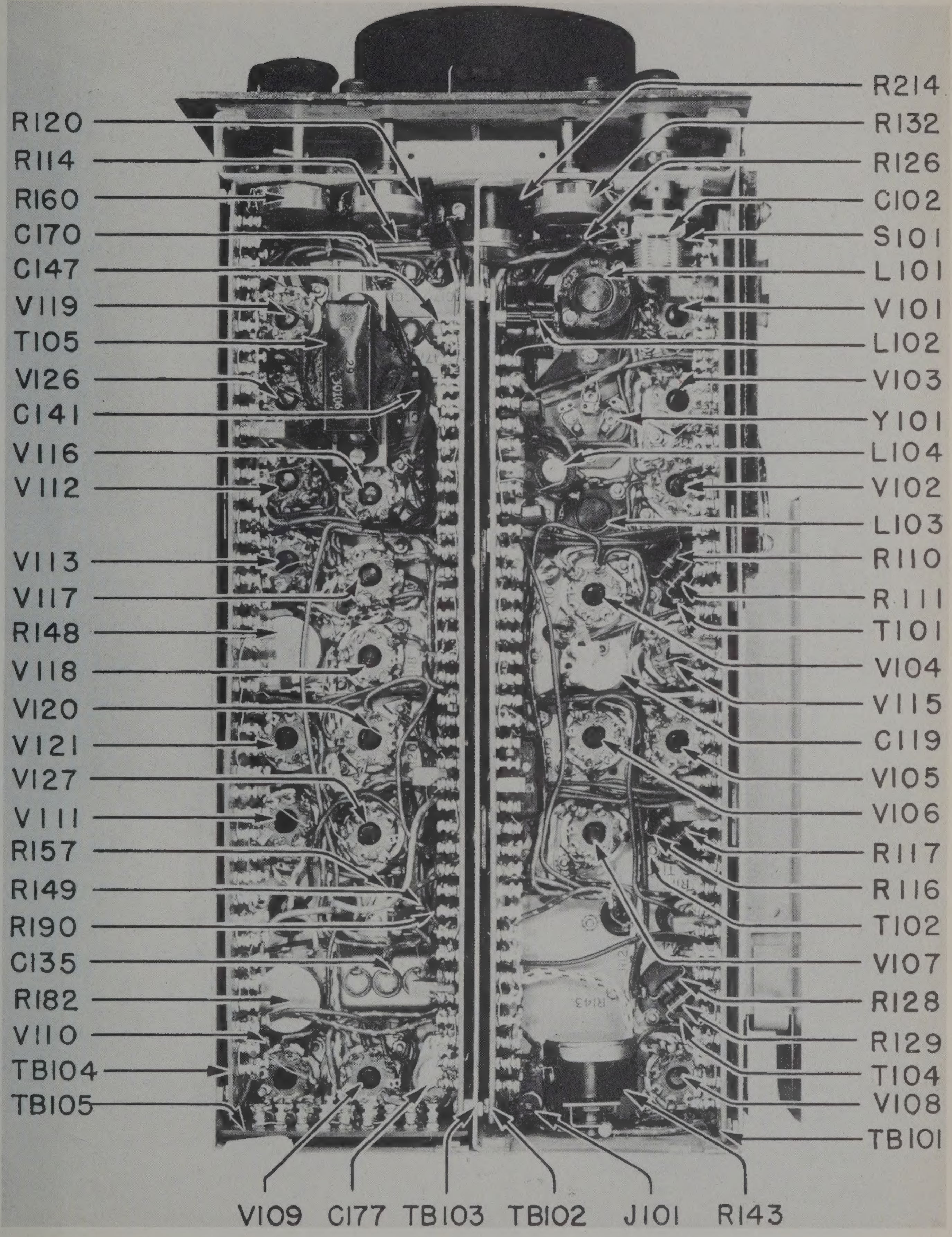

R120
R114
R160
C170
C147
V119
T105
V126
C141
V116
V112
V113
V117
R148
V118
V120
V121
V127
V111
R157
R149
R190
C135
R182
V110
TB104
TB105
R214
R132
R126
C102
S101
L101
V101
L102
V103
Y101
L104
V102
L103
R110
R111
T101
V104
V115
C119
V105
V106
R117
R116
T102
V107
R128
R129
T104
V108
TB101
V109
C177
TB103
TB102
J101
R143

Figure 7-16—Indicator Unit, Bottom View, Cover Plate Removed

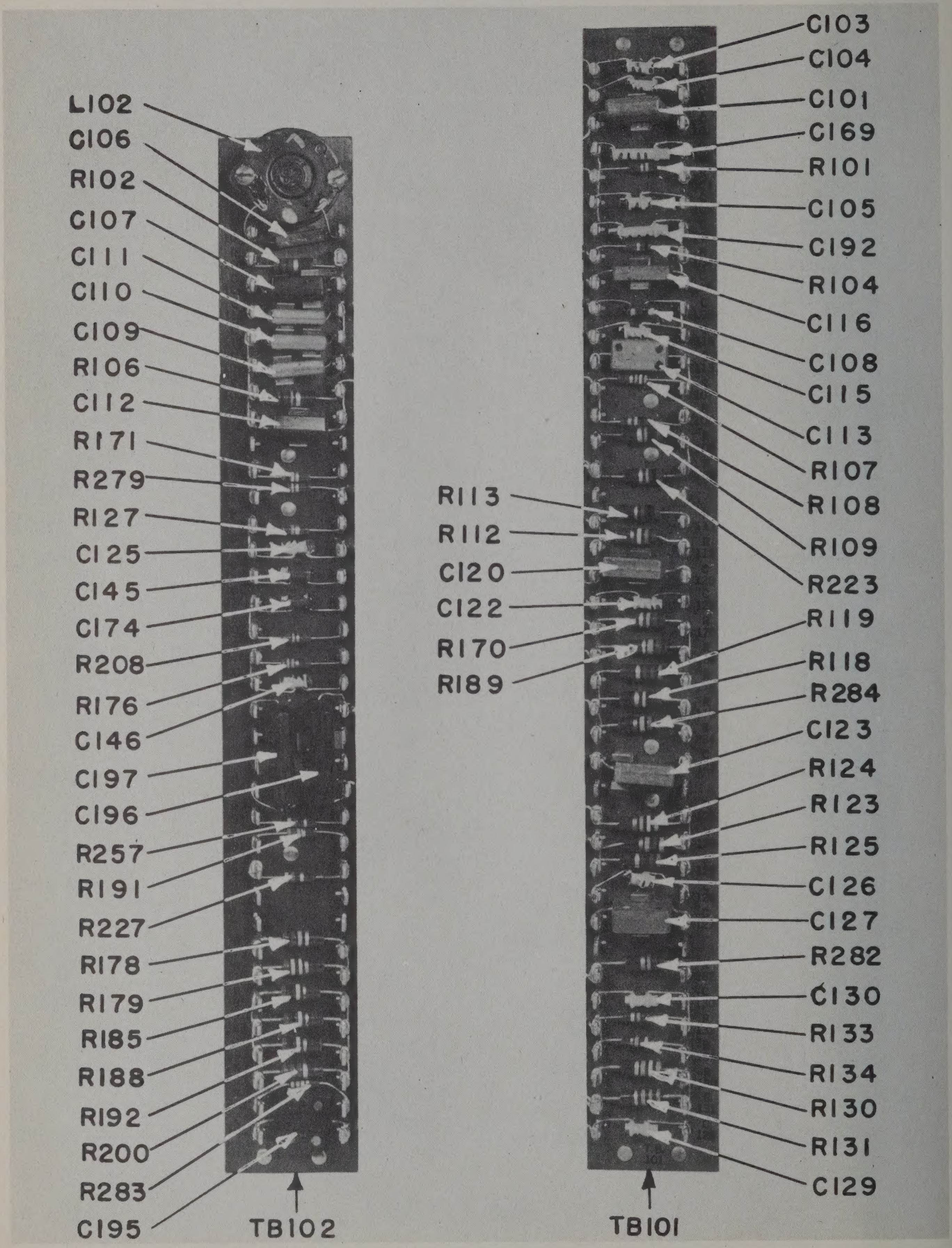

L102
C106
R102
C107
C111
C110
C109
R106
C112
R171
R279
R127
C125
C145
C174
R208
R176
C146
C197
C196
R257
R191
R227
R178
R179
R185
R188
R192
R200
R283
C195
TB102
R113
R112
C120
C122
R170
R189
TB101
C103
C104
C101
C169
R101
C105
C192
R104
C116
C108
C115
C113
R107
R108
R109
R223
R119
R118
R284
C123
R124
R123
R125
C126
C127
R282
C130
R133
R134
R130
R131
C129

Figure 7-17—Indicator Unit Terminal Boards TB101 and TB102

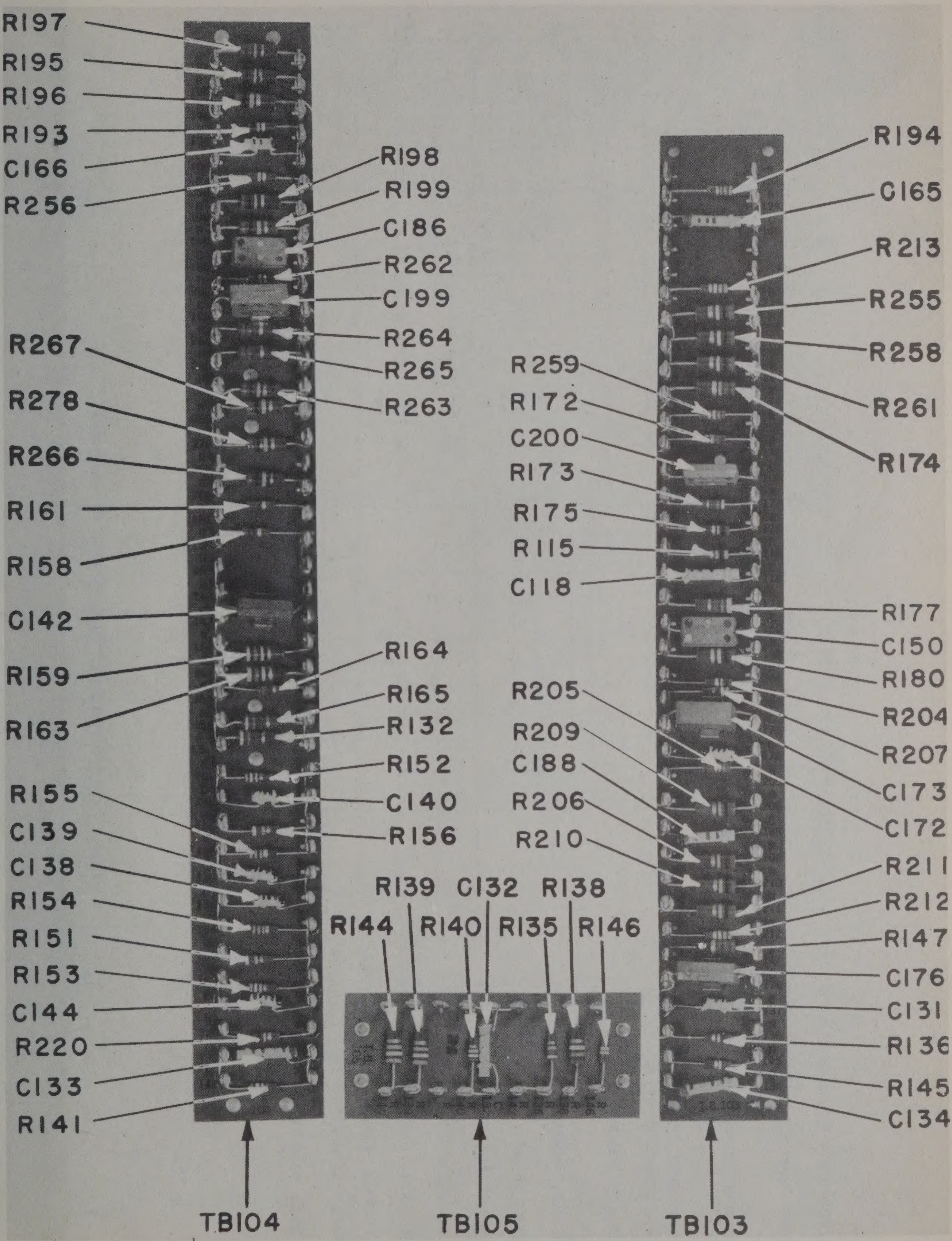

R197
R195
R196
R193
C166
R256
R198
R199
C186
R262
C199
R264
R265
R263
R267
R278
R266
R161
R158
C142
R159
R163
R164
R165
R132
R152
C140
R156
R155
C139
C138
R154
R151
R153
C144
R220
C133
R141
R139
C132
R138
R144
R140
R135
R146
R194
C165
R213
R255
R258
R261
R174
R259
R172
C200
R173
R175
R115
C118
R177
C150
R180
R204
R207
C173
C172
R205
R209
C188
R206
R210
R211
R212
R147
C176
C131
R136
R145
C134
TB104
TB105
TB103

Figure 7-18—Indicator Unit Terminal Boards, TB103, TB104, and TB105

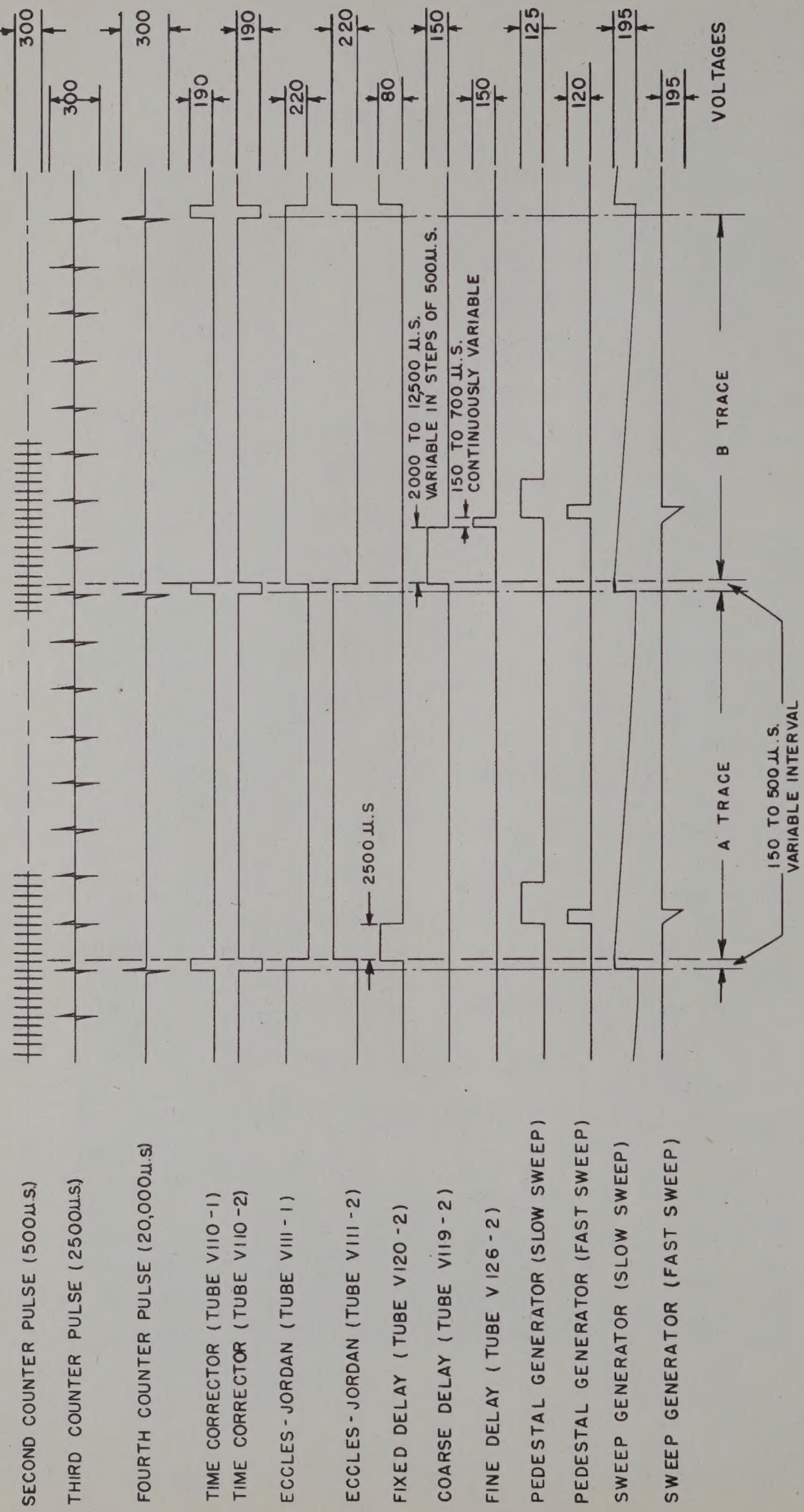

SECOND COUNTER PULSE (500µ.s.)
THIRD COUNTER PULSE (2500µ.s.)
FOURTH COUNTER PULSE (20,000µ.s)
TIME CORRECTOR (TUBE V110-1)
TIME CORRECTOR (TUBE V110-2)
ECCLES-JORDAN (TUBE V111-1)
ECCLES-JORDAN (TUBE V111-2)
FIXED DELAY (TUBE V120-2)
COARSE DELAY (TUBE V119-2)
FINE DELAY (TUBE V126-2)
PEDESTAL GENERATOR (SLOW SWEEP)
PEDESTAL GENERATOR (FAST SWEEP)
SWEEP GENERATOR (SLOW SWEEP)
SWEEP GENERATOR (FAST SWEEP)
2500µ.s
2000 TO 12500 µ.s.
VARIABLE IN STEPS OF 500µ.s.
150 TO 700 µ.s.
CONTINUOUSLY VARIABLE
A TRACE
B TRACE
150 TO 500µ.s.
VARIABLE INTERVAL
VOLTAGES
300
300
300
190
190
220
220
80
150
150
125
120
195
195

Figure 7-19—Waveforms, Showing Time Relationships

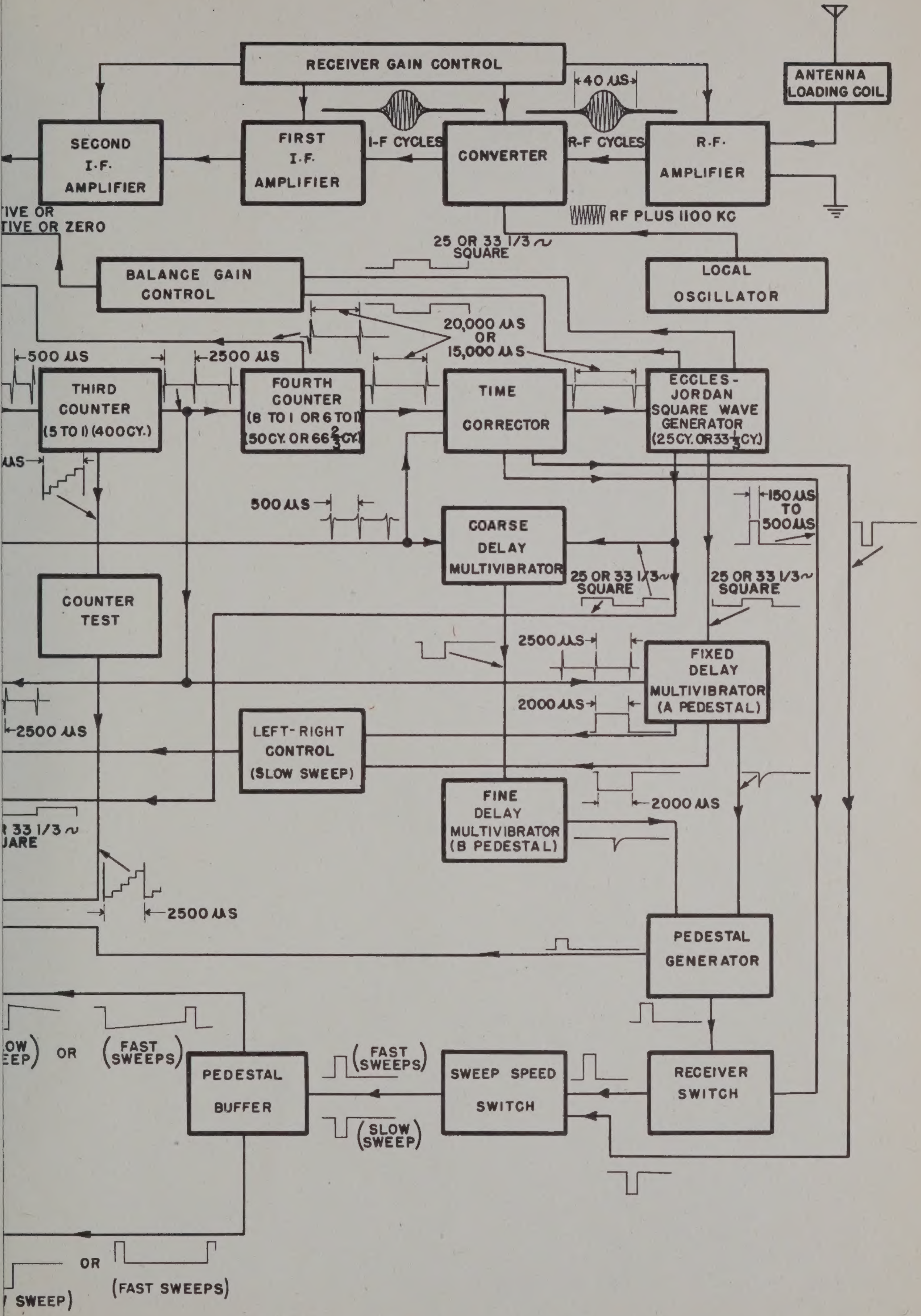

RECEIVER GAIN CONTROL
ANTENNA LOADING COIL
40 µS
SECOND I-F AMPLIFIER
FIRST I-F AMPLIFIER
I-F CYCLES
CONVERTER
R-F CYCLES
R-F AMPLIFIER
RF PLUS 1100 KC
IVE OR
TIVE OR ZERO
25 OR 33 1/3 ~ SQUARE
BALANCE GAIN CONTROL
LOCAL OSCILLATOR
20,000 µS OR 15,000 µS
500 µS
2500 µS
THIRD COUNTER (5 TO 1) (400 CY.)
FOURTH COUNTER (8 TO 1 OR 6 TO 1) (50 CY. OR 66 2/3 CY.)
TIME CORRECTOR
ECCLES-JORDAN SQUARE WAVE GENERATOR (25 CY. OR 33 1/3 CY.)
µS
500 µS
150 µS TO 500 µS
COARSE DELAY MULTIVIBRATOR
25 OR 33 1/3 ~ SQUARE
25 OR 33 1/3 ~ SQUARE
COUNTER TEST
2500 µS
FIXED DELAY MULTIVIBRATOR (A PEDESTAL)
2000 µS
2500 µS
LEFT-RIGHT CONTROL (SLOW SWEEP)
2000 µS
FINE DELAY MULTIVIBRATOR (B PEDESTAL)
R 33 1/3 ~
UARE
2500 µS
PEDESTAL GENERATOR
OW
EEP
OR
FAST SWEEPS
PEDESTAL BUFFER
FAST SWEEPS
SWEEP SPEED SWITCH
RECEIVER SWITCH
SLOW SWEEP
OR
SWEEP
FAST SWEEPS

Figure 7-20—Receiver-Indicator Unit Block Diagram, Showing Waveforms

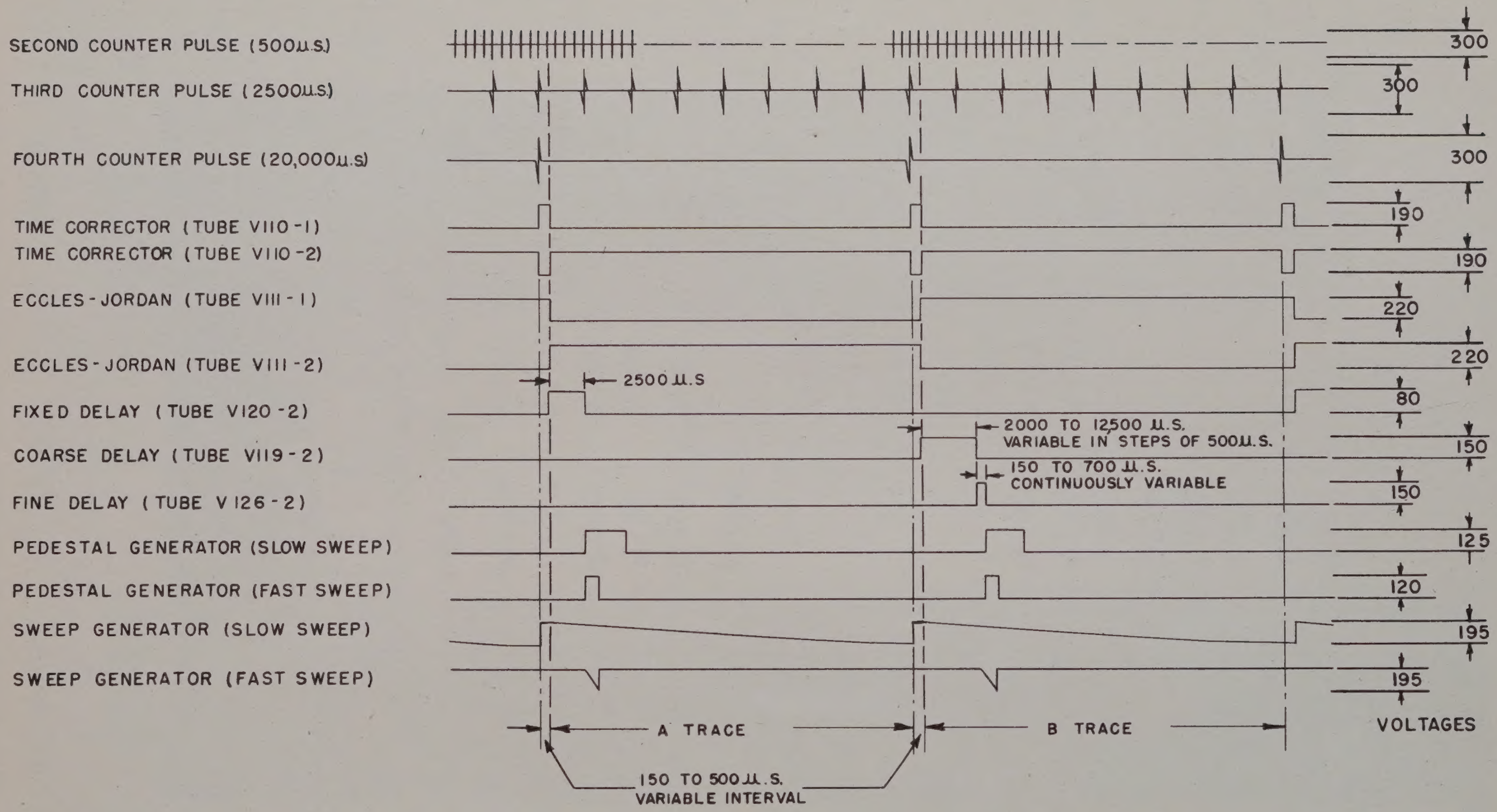

SECOND COUNTER PULSE (500µ.S.)
THIRD COUNTER PULSE (2500µ.S.)
FOURTH COUNTER PULSE (20,000µ.S.)
TIME CORRECTOR (TUBE V110-1)
TIME CORRECTOR (TUBE V110-2)
ECCLES-JORDAN (TUBE V111-1)
ECCLES-JORDAN (TUBE V111-2)
FIXED DELAY (TUBE V120-2)
COARSE DELAY (TUBE V119-2)
FINE DELAY (TUBE V126-2)
PEDESTAL GENERATOR (SLOW SWEEP)
PEDESTAL GENERATOR (FAST SWEEP)
SWEEP GENERATOR (SLOW SWEEP)
SWEEP GENERATOR (FAST SWEEP)
2500 µ.S
2000 TO 12,500 µ.S.
VARIABLE IN STEPS OF 500µ.S.
150 TO 700 µ.S.
CONTINUOUSLY VARIABLE
A TRACE
B TRACE
150 TO 500 µ.S.
VARIABLE INTERVAL
300
300
300
190
190
220
220
80
150
150
125
120
195
195
VOLTAGES

Figure 7-19—Waveforms, Showing Time Relationships

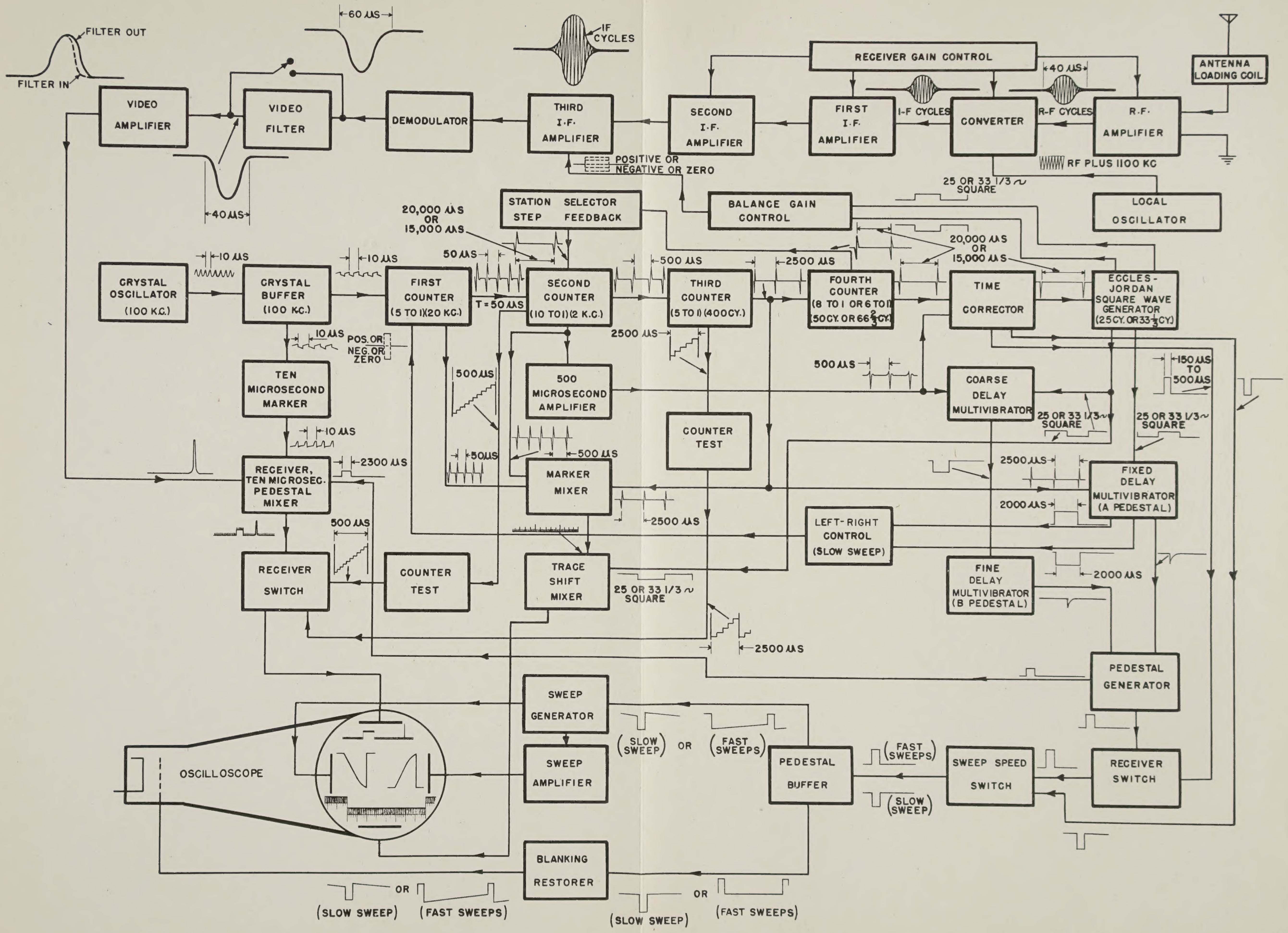

FILTER OUT
FILTER IN
60 µS
IF CYCLES
VIDEO AMPLIFIER
VIDEO FILTER
DEMODULATOR
THIRD I-F AMPLIFIER
SECOND I-F AMPLIFIER
FIRST I-F AMPLIFIER
I-F CYCLES
CONVERTER
R-F CYCLES
R.F. AMPLIFIER
ANTENNA LOADING COIL
RECEIVER GAIN CONTROL
40 µS
40 µS
POSITIVE OR NEGATIVE OR ZERO
RF PLUS 1100 KC
25 OR 33 1/3 ~ SQUARE
LOCAL OSCILLATOR
BALANCE GAIN CONTROL
STATION SELECTOR STEP FEEDBACK
20,000 µS OR 15,000 µS
20,000 µS OR 15,000 µS
CRYSTAL OSCILLATOR (100 K.C.)
10 µS
CRYSTAL BUFFER (100 KC.)
10 µS
FIRST COUNTER (5 TO 1)(20 KC.)
50 µS
T = 50 µS
SECOND COUNTER (10 TO 1)(2 K.C.)
500 µS
THIRD COUNTER (5 TO 1)(400 CY.)
2500 µS
FOURTH COUNTER (8 TO 1 OR 6 TO 1) (50 CY. OR 66 2/3 CY.)
TIME CORRECTOR
ECCLES-JORDAN SQUARE WAVE GENERATOR (25 CY. OR 33 1/3 CY.)
10 µS
POS. OR NEG. OR ZERO
TEN MICROSECOND MARKER
500 µS
500 MICROSECOND AMPLIFIER
2500 µS
500 µS
COARSE DELAY MULTIVIBRATOR
150 µS TO 500 µS
25 OR 33 1/3 ~ SQUARE
25 OR 33 1/3 ~ SQUARE
COUNTER TEST
10 µS
2300 µS
50 µS
500 µS
RECEIVER, TEN MICROSEC. PEDESTAL MIXER
MARKER MIXER
2500 µS
2000 µS
FIXED DELAY MULTIVIBRATOR (A PEDESTAL)
2500 µS
500 µS
LEFT-RIGHT CONTROL (SLOW SWEEP)
RECEIVER SWITCH
COUNTER TEST
TRACE SHIFT MIXER
25 OR 33 1/3 ~ SQUARE
FINE DELAY MULTIVIBRATOR (B PEDESTAL)
2000 µS
2500 µS
PEDESTAL GENERATOR
SWEEP GENERATOR
(SLOW SWEEP) OR (FAST SWEEPS)
OSCILLOSCOPE
SWEEP AMPLIFIER
PEDESTAL BUFFER
(FAST SWEEPS)
SWEEP SPEED SWITCH
(SLOW SWEEP)
RECEIVER SWITCH
BLANKING RESTORER
OR
(SLOW SWEEP) (FAST SWEEPS)
(SLOW SWEEP) OR (FAST SWEEPS)

Figure 7-20—Receiver-Indicator Unit Block Diagram, Showing Waveforms

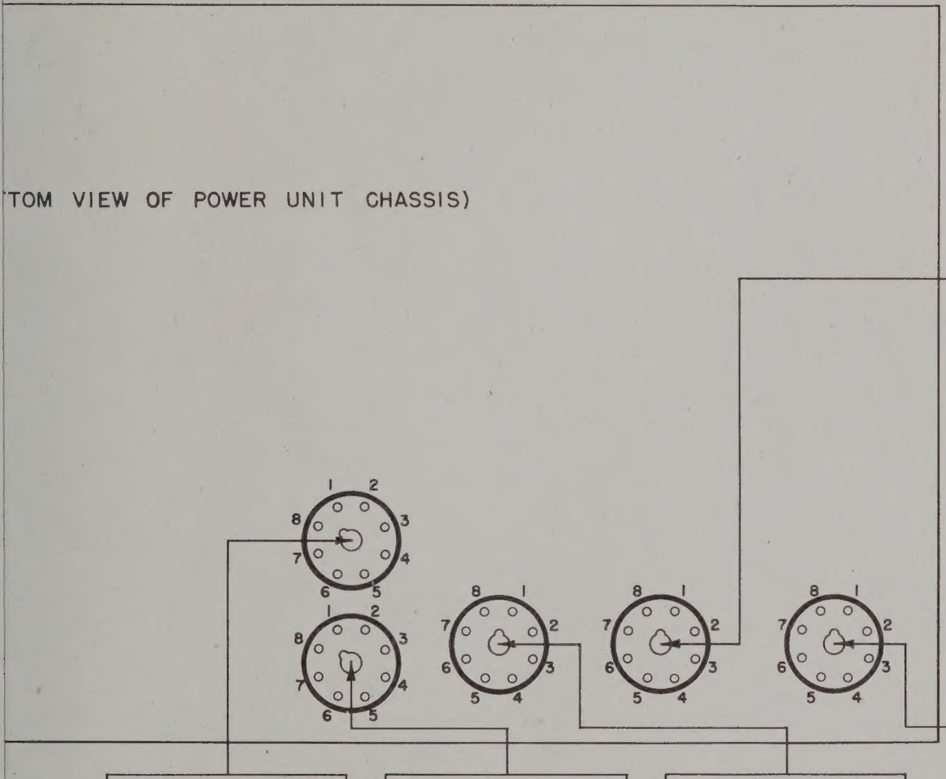
FRONT PANEL CONTROL SETTINGS
COARSE DELAY—FULL COUNTER CLOCKWISE
FINE DELAY—FULL COUNTER CLOCKWISE
BALANCE—CENTER POSITION
P.R.R.—L
STATION—0
RECEIVER—OFF
SWEEP SPEED—1
GAIN—2/3 CLOCKWISE FOR VOLTS
GAIN—FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATION

V302 —— 6Y6G

PIN	R	E	I
1	INF	—	
2	160 K	175	
3	INF	425	101.3*
4	INF	400	3.7*
5	INF	-1 TO PIN 8	
6	INF	—	
7	160 K	175	
8	7300	30	105*

V301 —— 5U4G

PIN	R	E	I
1	INF	—	
2	INF	440	
3	INF	—	
4	22	440 A. C.	105*
5	INF	—	
6	23	440 A. C.	105*
7	INF	—	
8	INF	440	



V305 —— VR150

PIN	R	E	I
1	INF	—	
2	0	GND	7.6
3	INF	—	
4	INF	—	
5	20 K	150	
6	INF	—	
7	INF	—	
8	INF	—	

V304 —— 6SL7

PIN	R	E	I
1	430K	145	
2	INF	320	NEGL.
3	20 K	150	NEGL.
4	37 K	65	
5	430K	115	
6	16.2 K	65	
7	160K	175	
8	160K	175	

V303 —— 6Y6G

PIN	R	E	I
1	INF	—	
2	160 K	175	
3	INF	425	101.3*
4	INF	400	3.7*
5	INF	-1 TO PIN 8	
6	INF	—	
7	160 K	175	
8	7300	307	105*

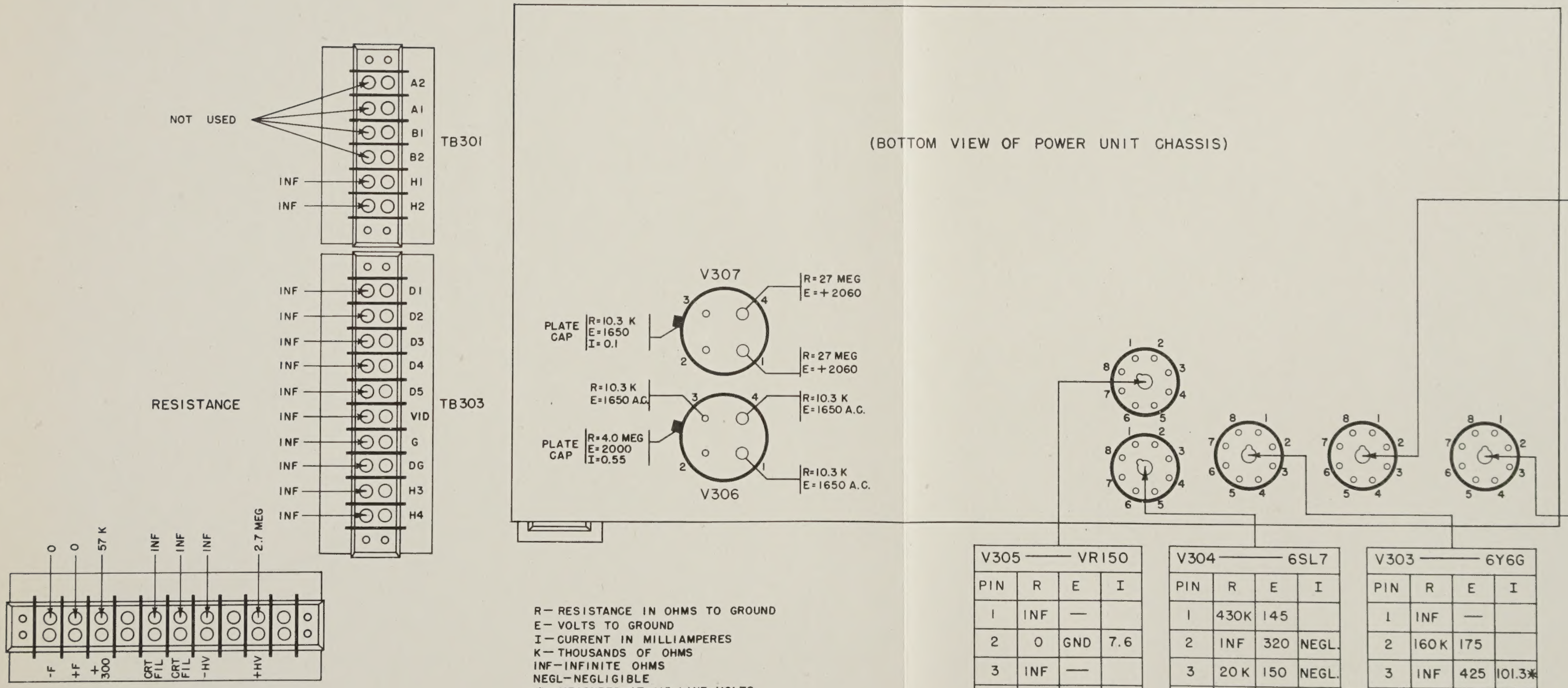
Figure 7-21—Power Supply Unit, Tube Socket Data

CONDITIONS FOR MEASUREMENT

A.— TERMINAL BOARD RESISTANCE
1. POWER SUPPLY UNIT DISCONNECTED FROM OTHER UNITS AT POWER SUPPLY TERMINAL BOARD.
2. RESISTANCE MEASURED TO GROUND.

B.— TUBE SOCKET MEASUREMENTS
1. ALL UNITS PROPERLY INTERCONNECTED & ALL TUBES IN PLACE.
2. RESISTANCE MEASURED WITH POWER SWITCH OFF.
3. VOLTMETER SENSITIVITY — 20,000 OHMS PER VOLT.
4. FOR CURRENT MEASUREMENTS, METER MUST BE BY-PASSED BY A 0.01 µF. OR LARGER CAPACITOR, PLACED AS NEAR AS POSSIBLE TO THE TUBE SOCKET.

FRONT PANEL CONTROL SETTINGS
COARSE DELAY — FULL COUNTER CLOCKWISE
FINE DELAY — FULL COUNTER CLOCKWISE
BALANCE — CENTER POSITION
P.R.R. — L
STATION — 0
RECEIVER — OFF
SWEEP SPEED — I
GAIN — 2/3 CLOCKWISE FOR VOLTS
GAIN — FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATION


NOT USED
A2
A1
B1
B2
INF
H1
INF
H2
TB301
INF D1
INF D2
INF D3
INF D4
INF D5
INF VID
INF G
INF DG
INF H3
INF H4
TB303
RESISTANCE
0
0
57 K
INF
INF
INF
2.7 MEG
-F
+F
+300
CRT FIL
CRT FIL
-HV
+HV
(BOTTOM VIEW OF POWER UNIT CHASSIS)
V307
PLATE CAP
R=10.3 K
E=1650
I=0.1
R=27 MEG
E=+2060
R=27 MEG
E=+2060
R=10.3 K
E=1650 A.C.
R=10.3 K
E=1650 A.C.
PLATE CAP
R=4.0 MEG
E=2000
I=0.55
R=10.3 K
E=1650 A.C.
V306
1
2
3
4
5
6
7
8

V302 — 6Y6G			
PIN	R	E	I
1	INF	—	
2	160 K	175	
3	INF	425	101.3✻
4	INF	400	3.7✻
5	INF	-1 TO PIN 8	
6	INF	—	
7	160 K	175	
8	7300	30	105✻

V301 — 5U4G			
PIN	R	E	I
1	INF	—	
2	INF	440	
3	INF	—	
4	22	440 A.C.	105✻
5	INF	—	
6	23	440 A.C.	105✻
7	INF	—	
8	INF	440	

V305 — VR150			
PIN	R	E	I
1	INF	—	
2	0	GND	7.6
3	INF	—	
4	INF	—	
5	20 K	150	
6	INF	—	
7	INF	—	
8	INF	—	

V304 — 6SL7			
PIN	R	E	I
1	430K	145	
2	INF	320	NEGL.
3	20 K	150	NEGL.
4	37 K	65	
5	430K	115	
6	16.2 K	65	
7	160K	175	
8	160K	175	

V303 — 6Y6G			
PIN	R	E	I
1	INF	—	
2	160K	175	
3	INF	425	101.3✻
4	INF	400	3.7✻
5	INF	-1 TO PIN 8	
6	INF	—	
7	160 K	175	
8	7300	307	105✻

R— RESISTANCE IN OHMS TO GROUND
E— VOLTS TO GROUND
I— CURRENT IN MILLIAMPERES
K— THOUSANDS OF OHMS
INF—INFINITE OHMS
NEGL—NEGLIGIBLE
✻—MEASURED AT 115 LINE VOLTS

Figure 7-21—Power Supply Unit, Tube Socket Data

ES IN PLACE

T

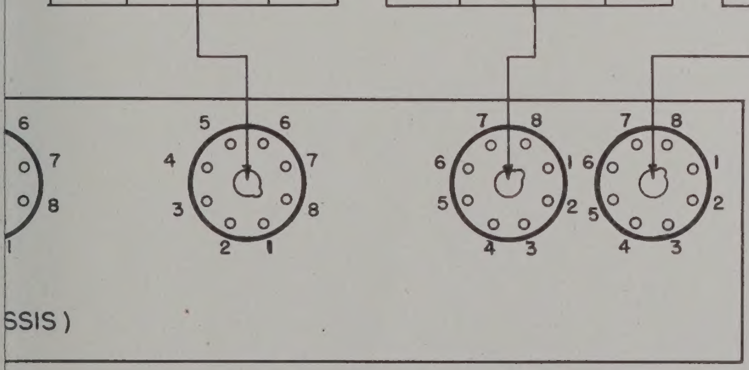
-PASSED
IEAR AS

FRONT PANEL CONTROL SETTINGS
COARSE DELAY — FULL COUNTER CLOCKWISE
FINE DELAY — FULL COUNTER CLOCKWISE
BALANCE — CENTER POSITION
P.R.R. —L
STATION - O
RECEIVER — OFF
SWEEP SPEED — I
GAIN — 2/3 CLOCKWISE FOR VOLTS
GAIN — FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATION

V405 — 6SK7 (6SG7) ✱			
PIN	R	E	I
1	0	GND.	
2	F-	GND.	
3	0	GND. (29) ✱	
4	16K	19	
5	2350	26.2 (29) ✱	11.3
6	54K	160	3.2
7	F+	6.3A.C.	
8	13K	265	8.1

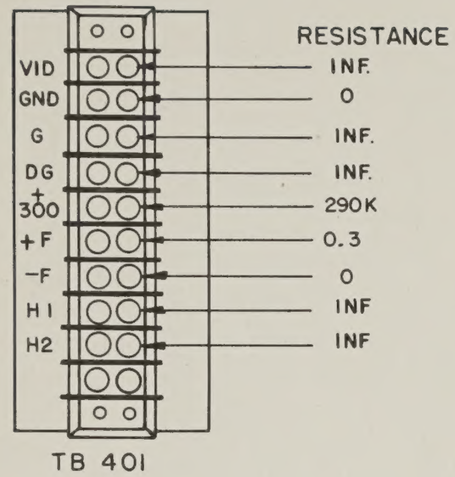
V406 — 6H6			
PIN	R	E	I
1	0	GND.	
2	F-	GND.	
3	240K	0.15	
4	0	GND.	
5	20K	0.07	
6	—	—	—
7	F+	6.3A.C.	
8	0	GND.	

V407 — 6AG7			
PIN	R	E	I
1	0	GND.	
2	F-	GND.	
3	0	GND.	
4	240K	-0.15	
5	0	GND.	
6	66K	56	15.8
7	F+	6.3A.C.	40
8	27K	54	11.8



R — RESISTANCE IN OHMS TO GROUND
E - VOLTS TO GROUND
I — CURRENT IN MILLIAMPERES
K — THOUSANDS OF OHMS
INF — INFINITE OHMS
✱ — UNITS BEFORE SERIAL NUMBER 405

Figure 7-22—Receiver Unit, Tube Socket Data



CONDITIONS FOR MEASUREMENT

A-TERMINAL BOARD RESISTANCE

1. RECEIVER DISCONNECTED FROM OTHER UNITS AT RECEIVER TERMINAL BOARD
2. RESISTANCE MEASURED TO GROUND.

B. TUBE SOCKET MEASUREMENTS

1. ALL UNITS PROPERLY INTERCONNECTED & ALL TUBES IN PLACE
2. RESISTANCE MEASURED WITH POWER SWITCH OFF
3. VOLTMETER SENSITIVITY — 20,000 OHMS PER VOLT
4. FOR CURRENT MEASUREMENTS, METER MUST BE BY-PASSED BY A 0.01 μ.f. OR LARGER CAPACITOR, PLACED AS NEAR AS POSSIBLE TO THE TUBE SOCKET.

FRONT PANEL CONTROL SETTINGS
COARSE DELAY — FULL COUNTER CLOCKWISE
FINE DELAY — FULL COUNTER CLOCKWISE
BALANCE — CENTER POSITION
P.R.R. — L
STATION - 0
RECEIVER — OFF
SWEEP SPEED — I
GAIN — 2/3 CLOCKWISE FOR VOLTS
GAIN— FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATION

V401 — 6AC7			
PIN	R	E	I
1	0	GND.	
2	F+	6.3A.C.	
3	160	0	
4	1.0	0	
5	160	20.5	12.0
6	69K	300	2.0
7	F−	GND.	
8	13K	300	10

V402 — 6SA7			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	13K	300	
4	30K	111	
5	22K	19	10.6
6	9	20.5	9.5
7	F+	6.3A.C.	
8	18K	0	1.1

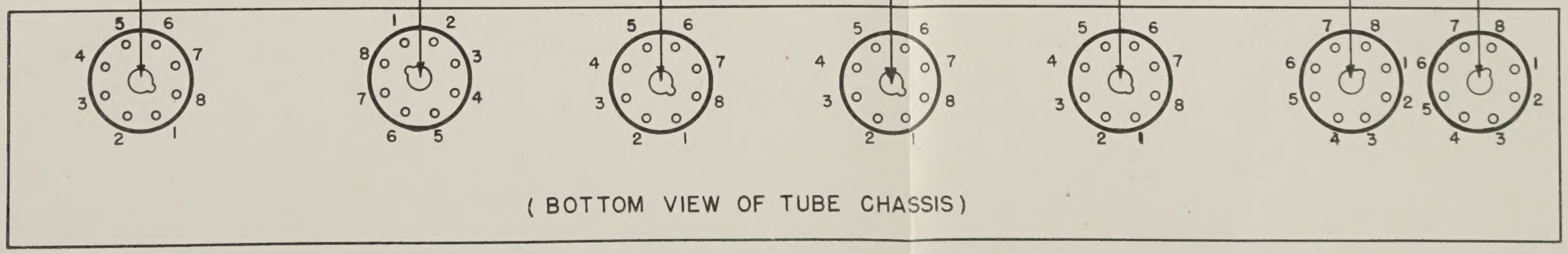
V403 — 6SK7 (6SG7) *			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	0	GND (1.0)*	
4	2	0	
5	270	22 (1.0)*	15.0
6	54K	230	3.4
7	F+	6.3A.C.	
8	13K	280	11.6

V404 — 6SK7			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	0	GND. (3.75)*	
4	2	0	
5	270	22 (3.75)*	13.5
6	63K	220	3.4
7	F+	6.3A.C.	
8	13K	280	10.1

V405 — 6SK7 (6SG7) *			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	0	GND. (29)*	
4	16K	19	
5	2350	26.2 (29)*	11.3
6	54K	160	3.2
7	F+	6.3A.C.	
8	13K	265	8.1

V406 — 6H6			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	240K	0.15	
4	0	GND.	
5	20K	0.07	
6	—	—	—
7	F+	6.3A.C.	
8	0	GND.	

V407 — 6AG7			
PIN	R	E	I
1	0	GND.	
2	F−	GND.	
3	0	GND.	
4	240K	-0.15	
5	0	GND.	
6	66K	56	15.8
7	F+	6.3A.C.	40
8	27K	54	11.8



R — RESISTANCE IN OHMS TO GROUND
E — VOLTS TO GROUND
I — CURRENT IN MILLIAMPERES
K — THOUSANDS OF OHMS
INF — INFINITE OHMS
* — UNITS BEFORE SERIAL NUMBER 405

Figure 7-22—Receiver Unit, Tube Socket Data

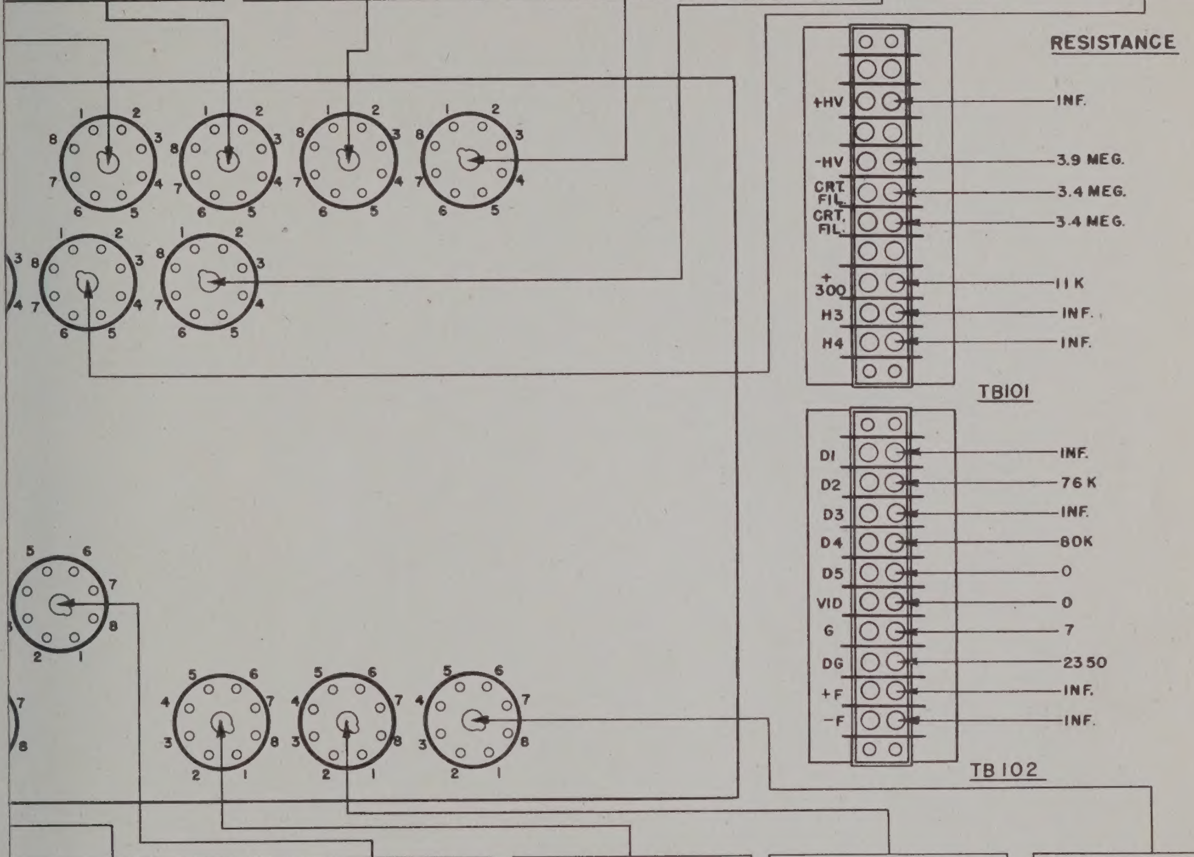
VI12 - 6SL7GT			
IN	R	E	I
1	1.5MEG.	160(4)	
2	7300	300	
3	300K	185(4)	0.5
4	1.5MEG.	160(4)	
5	7300	300	
6	150K	180	0.4
7	INF.	180(4)	
8	INF.	180(4)	

VI26 - 6SN7GT			
PIN	R	E	I
1	105K	52	
2	27K	235	
3	10K	78	0.04
4	2.4MEG.	42	
5	27K	210	
6	10K	78	7.8
7	INF.	80(4)	
8	INF.	80(4)	

VI19 - 6SN7GT			
PIN	R	E	I
1	130K	44(1)	
2	28K	280	
3	11.5K	80	0.2
4	3.4MEG.	75	
5	29K	150	
6	12K	80	6.9
7	F +	6.3A.C.	
8	F −	GND.	

VI16 - 6SL7GT			
PIN	R	E	I
1	56K	0	
2	29K	260	
3	4700	11	2.3
4	270K	-0.5	
5	270K	-0.5	
6	330K	0.4	NEGL.
7	F +	6.3A.C.	
8	F −	GND	

VI17 - 6SL7GT			
PIN	R	E	I
1	100K	-0.05(3)	
2	7300	300	
3	16.7K	19	0.4
4	1.5MEG.(5)	100A.C.(3)	
5	7300	300	
6	100K	46	0.5
7	F +	6.3A.C.	
8	F −	0	NEGL.



VI15 - 6SL7GT			
PIN	R	E	I
1	INF.	19	
2	7300	300	
3	56K	20	0.8
4	INF.	26	
5	7300	300	
6	56K	30	0.55
7	F+	6.3A.C	
8	F−	GND.	

VI04 - 6H6GT			
PIN	R	E	I
1	0	—	—
2	F−	GND.	
3	0	GND.	0.3
4	INF.	1.7(1)	
5	INF.	1.7(1)	
6	INF.	—	—
7	F +	6.3A.C.	
8	INF.	26	

VI02 - 6SN7GT			
PIN	R	E	I
1	100K	-27	
2	27K	170	
3	0	GND.	6.5
4	INF.	24.5	
5	7300	300	
6	4700(5)	60	9
7	F +	6.3A.C.	
8	F −	GND.	

VI03 - 6H6GT			
PIN	R	E	I
1	0	—	—
2	F −	GND.	
3	0	GND.	2.3
4	INF.	15.5	
5	INF.	15.5	
6	INF.		
7	F +	6.3A.C.	
8	INF.	22	

VI01 - 6SL7GT			
PIN	R	E	I
1	115K	-20(1)	
2	10K	300	
3	0	GND.	3.5
4	1 MEG.	-15(1)	
5	7300	300	
6	23K	25	1.5
7	F +	6.3A.C.	
8	F −	GND.	

CONTROL SETTINGS
FULL COUNTER CLOCKWISE
FULL COUNTER CLOCKWISE
CENTER POSITION
F
I
LOCKWISE FOR VOLTS
LOCKWISE FOR CURRENT
ET FOR NORMAL OPERATIONS

R -RESISTANCE IN OHMS TO GROUND
E - VOLTS TO GROUND
I - CURRENT IN MILLIAMPERES
K - THOUSANDS OF OHMS
INF. -INFINITE OHMS
NEGL.-NEGLIGIBLE
(1)-250 VOLT SCALE ONLY
(2)-50 VOLT SCALE ONLY
(3)-VARIES OVER LARGE RANGE WITH DIFFERENT METERS.
(4)-1,000 VOLT SCALE ONLY
(5)-RESISTANCE VARIES WITH SETTING OF POTENTIOMETER IN CIRCUIT.

Figure 7-23—Indicator Unit, Tube Socket Data, Main Chassis

V110- 6SN7GT

PIN	R	E	I
1	410K	37	
2	40K	90	
3	4300	38	5.7
4	410K	16	
5	42 K	275	
6	4300	38	0.15
7	F+	6.3AC	
8	F-	GND.	

V127- 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	330K	-3(3)	
4	INF.	-1 (3)	
5	INF.	-1 (3)	NEGL.
6	INF.	—	—
7	F+	6.3A.C	
8	0	GND.	NEGL.

V111 - 6SN7GT

PIN	R	E	I
1	73K	29	
2	43K	160	
3	6000(5)	29	2.7
4	75K	30(1)	
5	43K	165	
6	6000(5)	29	2.7
7	F+	6.3A.C	
8	F-	GND.	

V121- 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	330K	-2 (3)	
4	330K	-1 (3)	
5	330K	-1 (3)	
6	INF.	—	—
7	F+	6.3 A.C.	
8	0	GND.	

V113 - 6SN7GT

PIN	R	E	I
1	2.7 MEG	NEGL.	—
2	7300	300	
3	2300	25	NEGL.
4	2.7MEG.	NEGL.	
5	7300	300	
6	2300	25	NEGL.
7	F+	6.3A.C.	
8	F-	GND.	

V112 - 6SL7GT

PIN	R	E	I
1	1.5MEG.	160(4)	
2	7300	300	
3	300K	185(4)	0.5
4	1.5MEG	160(4)	
5	7300	300	
6	150K	180	0.4
7	INF.	180(4)	
8	INF.	180(4)	

V126- 6SN7GT

PIN	R	E	I
1	105K	52	
2	27K	235	
3	10 K	78	0.04
4	2.4MEG.	42	
5	27K	210	
6	10 K	78	7.8
7	INF.	80(4)	
8	INF.	80(4)	

V119 - 6SN7GT

PIN	R	E	I
1	130K	44 (1)	
2	28 K	280	
3	11.5 K	80	0.2
4	3.4MEG.	75	
5	29K	150	
6	12 K	80	6.9
7	F+	6.3A.C.	
8	F-	GND.	

V116- 6SL7GT

PIN	R	E	I
1	56K	0	
2	29K	260	
3	4700	11	2.3
4	270K	-0.5	
5	270K	-0.5	
6	330K	0.4	NEGL.
7	F+	6.3A.C.	
8	F-	GND	

V117 - 6SL7GT

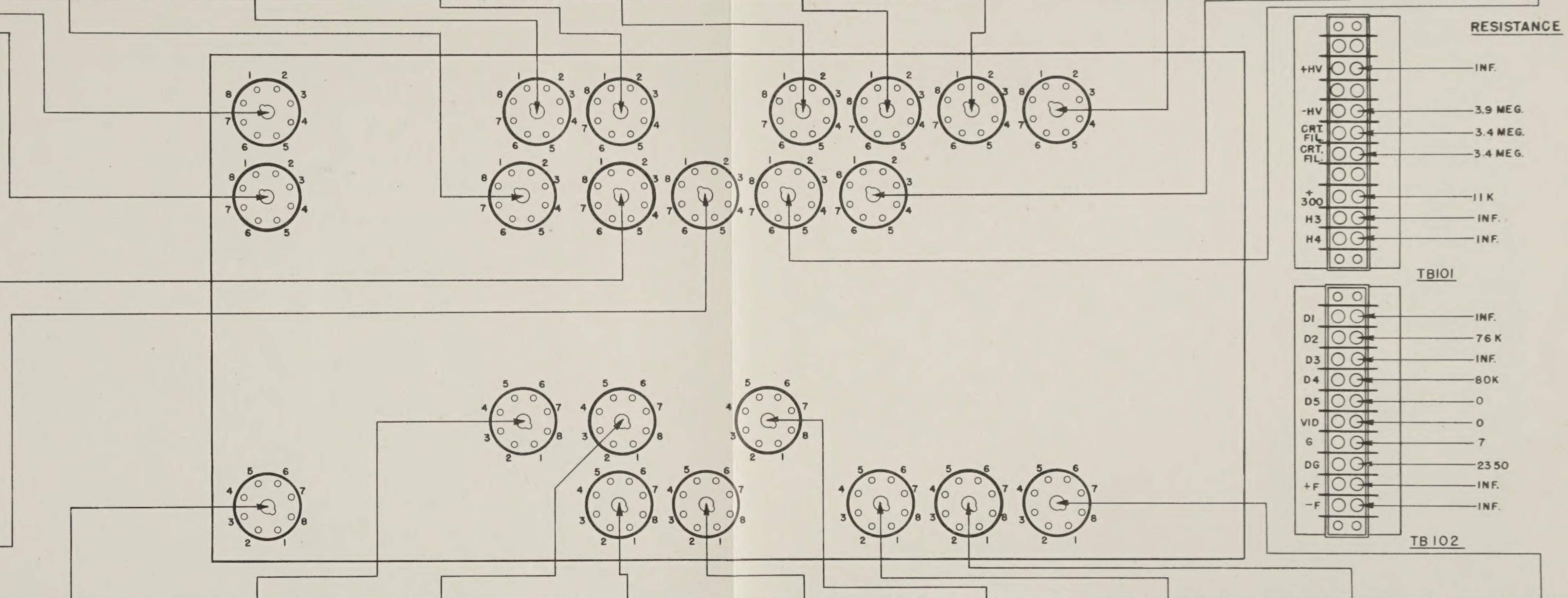
PIN	R	E	I
1	100K	-0.05(3)	
2	7300	300	
3	16.7K	19	0.4
4	1.5MEG.(5)	100A.C(3)	
5	7300	300	
6	100K	46	0.5
7	F+	6.3A.C	
8	F-	0	NEGL.

V109 - 6H6GT

PIN	R	E	I
1	0	—	—
2	F+	6.3A.C.	
3	410K	16	
4	91 K	16	
5	150K	-0.5(3)	
6	INF.	—	—
7	F-	GND.	
8	150K	0.5(3)	

V120- 6SL7GT

PIN	R	E	I
1	120 K(5)	20	
2	27K	300	
3	10K	41	0.14
4	3.9 MEG.	40	
5	27K	220	
6	10K	41	4.2
7	F+	6.3 A.C.	
8	F-	GND.	



V118 - 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	0	NEGL.	
4	0	NEGL.	NEGL.
5	0	—	—
6	INF.	—	—
7	F+	6.3 A.C.	
8	INF.	26	NEGL.

V108 - 6SN7GT

PIN	R	E	I
1	INF.	43(1)	
2	7300	300	
3	15K(5)	61	0.07
4	410K	37	
5	410K	37	
6	91 K	37	0.11
7	F-	GND.	
8	F+	6.3 A.C.	

V107 - 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	0	GND.	
4	INF.	2 (3)	NEGL.
5	INF.	2 (3)	
6	INF.	—	—
7	F+	6.3A.C.	
8	INF.	4.3 (1)	NEGL.

V106- 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	0	GND.	0.03
4	INF.	1.0 (3)	
5	INF.	1.0 (3)	
6	INF.	—	—
7	F+	6.3 A.C.	
8	INF.	19 (2)	

V105- 6SN7GT

PIN	R	E	I
1	INF.	26	
2	7300	300	
3	14K(5)	67	1.3
4	INF.	19 (2)	
5	7300	300	
6	10.5K	50	0.3
7	F+	6.3A.C.	
8	F-	GND.	

V115 - 6SL7GT

PIN	R	E	I
1	INF.	19	
2	7300	300	
3	56 K	20	0.8
4	INF.	26	
5	7300	300	
6	56K	30	0.55
7	F+	6.3A.C	
8	F-	GND.	

V104- 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	0	GND.	0.3
4	INF.	1.7 (1)	
5	INF.	1.7 (1)	
6	INF.	—	—
7	F+	6.3A.C.	
8	INF.	26	

V102- 6SN7GT

PIN	R	E	I
1	100K	-27	
2	27K	170	
3	0	GND.	6.5
4	INF.	24.5	
5	7300	300	
6	4700(5)	60	9
7	F+	6.3A.C.	
8	F-	GND.	

V103- 6H6GT

PIN	R	E	I
1	0	—	—
2	F-	GND.	
3	0	GND.	2.3
4	INF.	15.5	
5	INF.	15.5	
6	INF.		
7	F+	6.3A.C.	
8	INF.	22	

V101- 6SL7GT

PIN	R	E	I
1	115K	-20(1)	
2	10K	300	
3	0	GND.	3.5
4	1 MEG.	-15(1)	
5	7300	300	
6	23K	25	1.5
7	F+	6.3A.C	
8	F-	GND.	

CONDITIONS FOR MEASUREMENT

A. TERMINAL BOARD RESISTANCE
  1. INDICATOR DISCONNECTED FROM OTHER UNITS A INDICATOR TERMINAL BOARD.
  2. RESISTANCE MEASURED TO GROUND.

B. TUBE SOCKET MEASUREMENTS
  1. ALL UNITS PROPERLY INTERCONNECTED AND ALL TUBES IN PLACE.
  2. RESISTANCE MEASURED WITH POWER SWITCH OFF.
  3. VOLTMETER SENSITIVITY-20,000 OHMS PER VOLT.
  4. FOR CURRENT MEASUREMENTS, METER MUST BE BY-PASSED BY A 0.01 µ.F. OR LARGER CAPACITOR, PLACED AS NEAR AS POSSIBLE TO THE TUBE SOCKET.

FRONT PANEL CONTROL SETTINGS

COURSE DELAY — FULL COUNTER CLOCKWISE
FULL DELAY — FULL COUNTER CLOCKWISE
BALANCE — CENTER POSITION
P. R. R. — L
STATION — 0
RECEIVER — OFF
SWEEP SPEED — 1
GAIN — 2/3 CLOCKWISE FOR VOLTS
GAIN — FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATIONS

R -RESISTANCE IN OHMS TO GROUND
E - VOLTS TO GROUND
I - CURRENT IN MILLIAMPERES
K - THOUSANDS OF OHMS
INF. -INFINITE OHMS
NEGL.-NEGLIGIBLE
(1)-250 VOLT SCALE ONLY
(2)-50 VOLT SCALE ONLY
(3)-VARIES OVER LARGE RANGE WITH DIFFERENT METERS.
(4)-1,000 VOLT SCALE ONLY
(5)-RESISTANCE VARIES WITH SETTING OF POTENTIOMETER IN CIRCUIT.

Figure 7-23—Indicator Unit, Tube Socket Data, Main Chassis

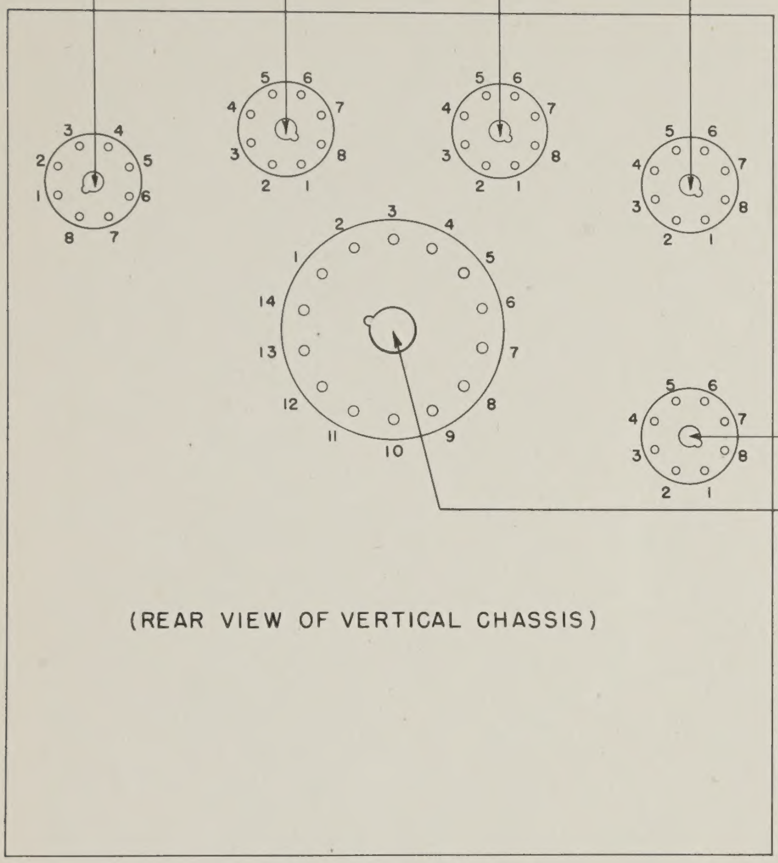
Figure 7-24—Indicator Unit, Tube Socket Data, Vertical Chassis

V125	—		
PIN.	R	E	I
1	0	—	—
2	F−	GND.	
3	167K	175	
4	INF.	—	—
5	39K	10(2)	
6	INF.	—	
7	F +	6.3A.C.	
8	4000(5)	10	0.9

V124	—	6SK7GT OR 6SJ7GT	
PIN	R	E	I
1	0	GND.	
2	F-	GND.	
3	2.7MEG	-5	
4	4.0MEG	-8.5	
5	0	GND.	5.3
6	75K	202	1.6
7	F+	6.3A.C.	
8	43K	150	3.7

V128	—	6SN7GT	
PIN	R	E	I
1	130K	50	
2	17.3K	300	
3	6800	80	0.8
4	3.9MEG.	78	
5	17K	205	
6	6800	80	11
7	F −	GND.	
8	F +	6.3A.C.	

V114	—	6J5GT	
PIN	R	E	I
1	0	GND.	
2	F +	6.3A.C.	
3	7300	300	
4	INF	—	—
5	3 MEG.	40(4)	
6	INF.	—	—
7	F −	GND.	
8	220K	80	0.3



V123	—	6SN7GT	
PIN	R	E	I
1	320K	100(4)	
2	7300	300	
3	100K	120	1.2
4	2.7MEG.	4.5(3)	
5	2.7MEG.	−4.5(3)	
6	0	GND.	NEGL.
7	F −	GND.	
8	F +	6.3A.C.	

V129	—	5CP1
PIN	R	E
1	3.4 MEG.	−1570
2	3.4 MEG.	−1570
3	7 MEG.	−1700
4	INF.	—
5	2.4 MEG.	−1100
6	INF.	—
7	1.2 MEG.	125
8	2 MEG.	115
9	510 K	162
10	167	175
11	43 K	152
12	INF.	—
13	INF.	—
14	3.4 MEG.	−1570
ANODE CAP	27 MEG.	2060

V122	MOUNTED ON H.V.TERM. BOARD6K6GT		
PIN	R	E	I
1	3.4MEG.	—	—
2	3.4MEG.	−1570	H
3	7 MEG.	−1700	
4	3.4MEG.	−1600	
5	7MEG.	−1700	
6	INF.	—	—

CONDITIONS FOR MEASUREMENT

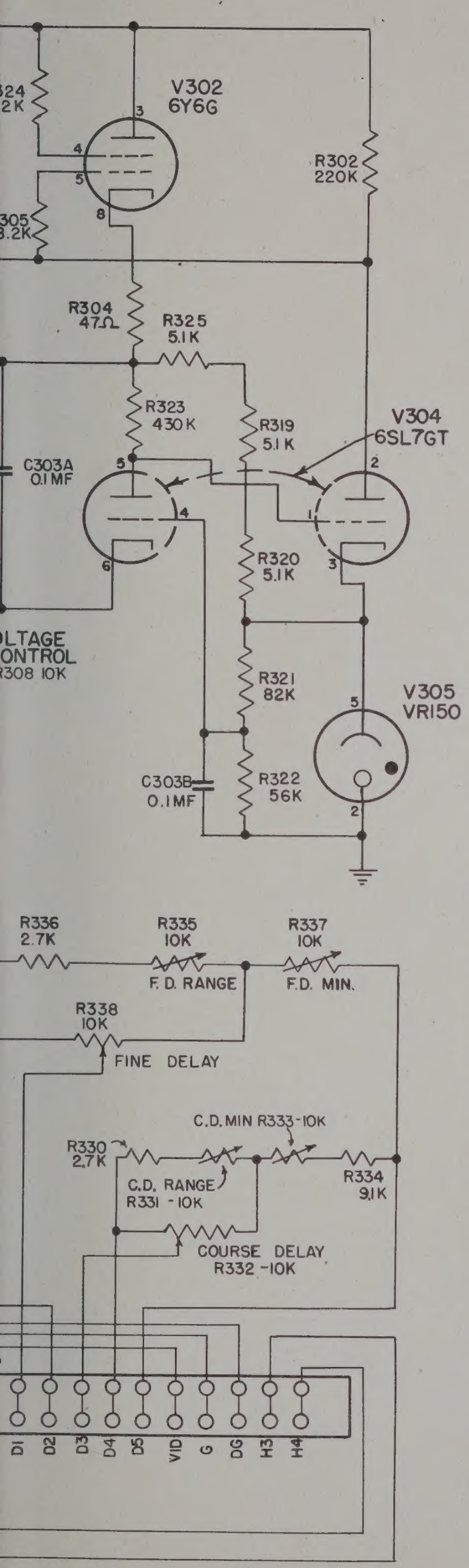
A. TERMINAL BOARD RESISTANCE
  1. INDICATOR DISCONNECTED FROM OTHER UNITS AT INDICATOR TERMINAL BOARD.
  2. RESISTANCE MEASURED TO GROUND

B. TUBE SOCKET MEASUREMENTS
  1. ALL UNITS PROPERLY INTERCONNECTED AND ALL TUBES IN PLACE.
  2. RESISTANCE MEASURED WITH POWER SWITCH OFF.
  3. VOLTMETER SENSITIVITY − 20,000 OHMS PER VOLT.
  4. FOR CURRENT MEASUREMENTS, METER MUST BE BY-PASSED BY A 0.01 µ.F. OR LARGER CAPACITOR, PLACED AS NEAR AS POSSIBLE TO THE TUBE SOCKET.

FRONT PANEL CONTROL SETTINGS
COURSE DELAY − FULL COUNTER CLOCKWISE
FULL DELAY — FULL COUNTER CLOCKWISE
BALANCE — CENTER POSITION
P.R.R. — L
STATION — O
RECEIVER — OFF
SWEEP SPEED — I
GAIN − 2/3 CLOCKWISE FOR VOLTS
GAIN − FULL CLOCKWISE FOR CURRENT
ADJUSTMENTS SET FOR NORMAL OPERATION

R - RESISTANCE IN OHMS TO GROUND
E - VOLTS TO GROUND
I - CURRENT IN MILLIAMPERES
K - THOUSANDS OF OHMS
INF.- INFINITE OHMS
NEGL.- NEGLIGIBLE
(1) - 250 VOLT SCALE ONLY
(2) - 50 VOLT SCALE ONLY
(3) - VARIES OVER LARGE RANGE WITH DIFFERENT METERS
(4) - 1000 VOLT SCALE ONLY
(5) - VARIES WITH SETTING OF POTENTIOMETER IN CIRCUIT

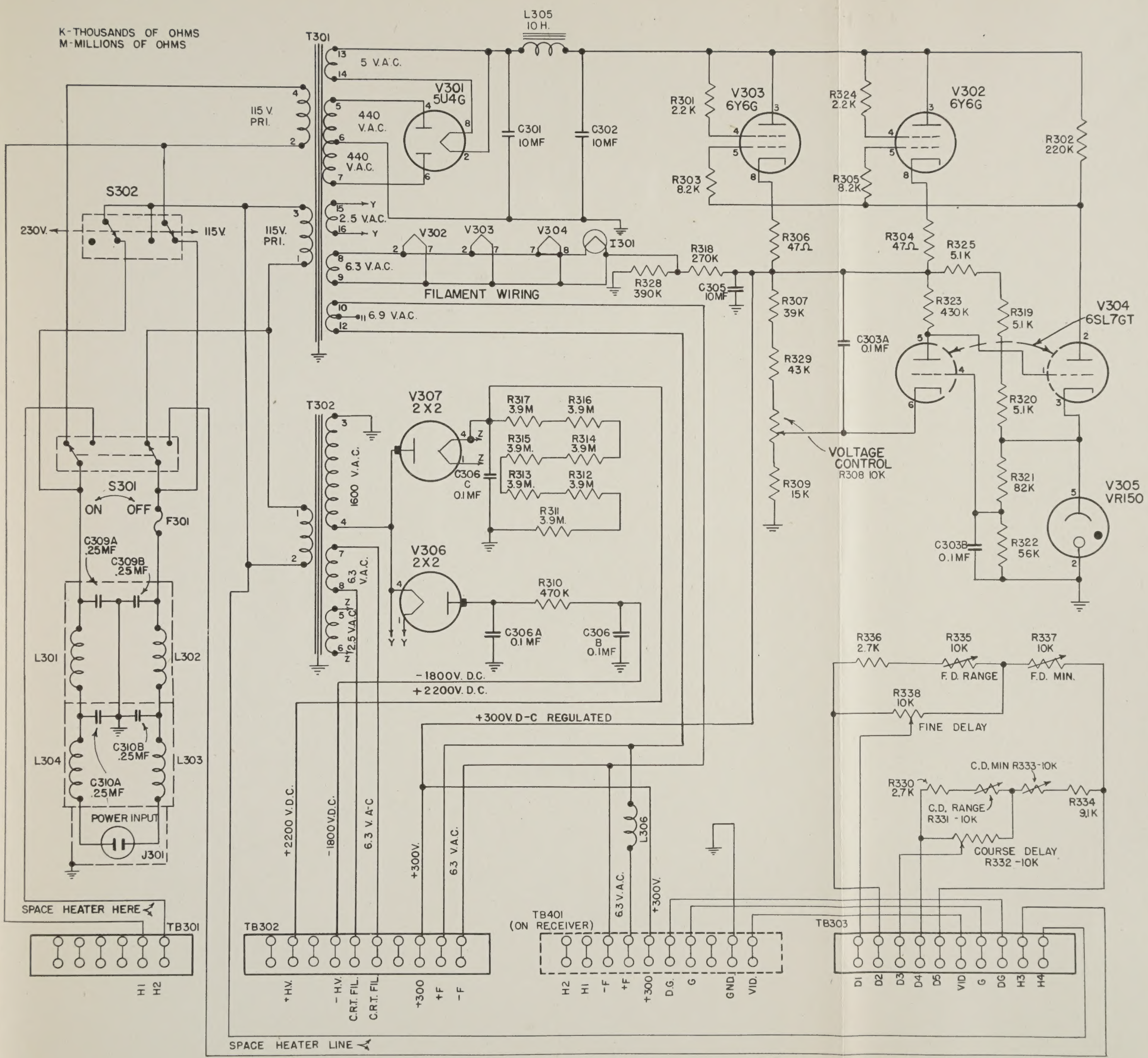
Figure 7-24—Indicator Unit, Tube Socket Data, Vertical Chassis


V302
6Y6G
324
2K
305
3.2K
R302
220K
R304
47Ω
R325
5.1K
R323
430K
R319
5.1K
V304
6SL7GT
C303A
0.1MF
R320
5.1K
LTAGE
ONTROL
308 10K
R321
82K
V305
VR150
C303B
0.1MF
R322
56K
R336
2.7K
R335
10K
R337
10K
F.D. RANGE
F.D. MIN.
R338
10K
FINE DELAY
C.D. MIN R333-10K
R330
2.7K
R334
9.1K
C.D. RANGE
R331 - 10K
COURSE DELAY
R332 -10K
D1
D2
D3
D4
D5
VID
G
DG
H3
H4

SYM.	DESCRIPTION
	UNLESS OTHERWISE SPECIFIED ALL
	RESISTORS ARE INSULATED CARBON
R301	RESISTOR 2200 Ω ±10% 1/2 W.
R302	220,000Ω ± 5 % 1W.
R303	8,200 Ω ±10% 1/2W
R304	47 Ω ±10 % 1 W.
R305	8,200 Ω ±10% 1/2 W.
R306	47 Ω ±10% 1W.
R307	RESISTOR 39000 Ω ±5% 1W.
R308	POTENTIOMETER 10,000 Ω ±10% WW
R309	RESISTOR 15,000 Ω ± 5 % 1W
R310	470,000 Ω ±10% 1W
R311	3.9 MEG Ω ±10% 1W
R312	3.9 MEG Ω ±10% 1W
R313	3.9 MEG Ω ±10% 1W
R314	3.9 MEG Ω ±10% 1W
R315	3.9 MEG. Ω ±10% 1W
R316	3.9 MEG. Ω ±10% 1W
R317	3.9 MEG Ω ±10% 1W
R318	270,000 Ω ±10% 1W
R319	5,100 Ω ±5% 1W
R320	5,100 Ω ±5% 1W
R321	82,000 ±5% 1/2W
R322	56,000 Ω ±5% 1/2 W.
R323	430,000 Ω ±5% 1W.
R324	2,200 Ω ±10% 1/2 W.
R325	RESISTOR 5,100 Ω ± 5% 1W.
R326	
R327	
R328	RESISTOR 390,000 Ω ±10% 1W.
R329	RESISTOR 43,000 Ω ±5% 1W.
R330	RESISTOR 2700 Ω ± 5% 1W.
R331	POTENTIOMETER 10,000 Ω ±10% WW 2W
R332	POTENTIOMETER 10,000 Ω ±5% WW 4W
R333	POTENTIOMETER 10,000 Ω ±10% WW 2W
R334	RESISTOR 9,100 Ω ± 5% 1W
R335	POTENTIOMETER 10,000 Ω ±10% WW 2W
R336	RESISTER 2,700 Ω ± 5 % 1W.
R337	POTENTIOMETER 10,000 Ω ±10% WW2W
R338	POTENTIOMETER 10,000 Ω ± 5 % 4 W
C301	CAPACITOR - PAPER 10 MFD ±10% 1000V.
C302	10 MFD ±10% 600 V.
C303	(A) 0.1 MFD ±15 % 600V.
C303	(B) 0.1 MFD ±15% 600V.
C305	10 MFD ±10% 600V.
C306	(A) 0.1 MFD ±10 % 3000V.
C306	(B) 0.1 MFD ±10% 3000V.
C306	(C) 0.1 MFD ±10% 3000V.
C309	(A) 0.25 MFD ±20% 600V
C309	(B) 0.25 MFD ±20% 600V
C310	(A) 0.25 MFD ±20% 600V
C310B	CAPACITOR PAPER 0.25 MFD ±20% 600V.
F301	FUSE FOR 115V 5A LITTLE FUSE 1094 OR EQUIV.
	FUSE FOR 230V - 2.0A LITTLE FUSE 1094 OR EQUIV.
L301	FILTER COIL (LINE)
L302	
L303	
L304	FILTER COIL (LINE)
L305	FILTER REACTOR - 10HY .180 MA.
L306	FILAMENT CHOKE

SYM	DESCRIPTION
PL301	CONNECTOR RECEPTACLE
S301	SWITCH - D.P.D.T. TOGGLE "ON" "OFF"
S302	SWITCH - D.P.D.T. 115V - 230V.
T301	TRANSFORMER - POWER
T302	TRANSFORMER - H.V.
TB301	JUNCTION BOARD
TB302	TERMINAL BOARD HIGH VOLTAGE
TB303	TERMINAL BOARD LOW VOLTAGE
V301	TUBE 5U4G RECTIFIER
V302	6Y6G REGULATOR
V303	6Y6G REGULATOR
V304	6SL7GT REG. AMPLIFIER
V305	VR 150 VOLTAGE REG.
V306	2 X 2 H.V. RECTIFIER
V307	TUBE 2 X 2 H.V. RECTIFIER

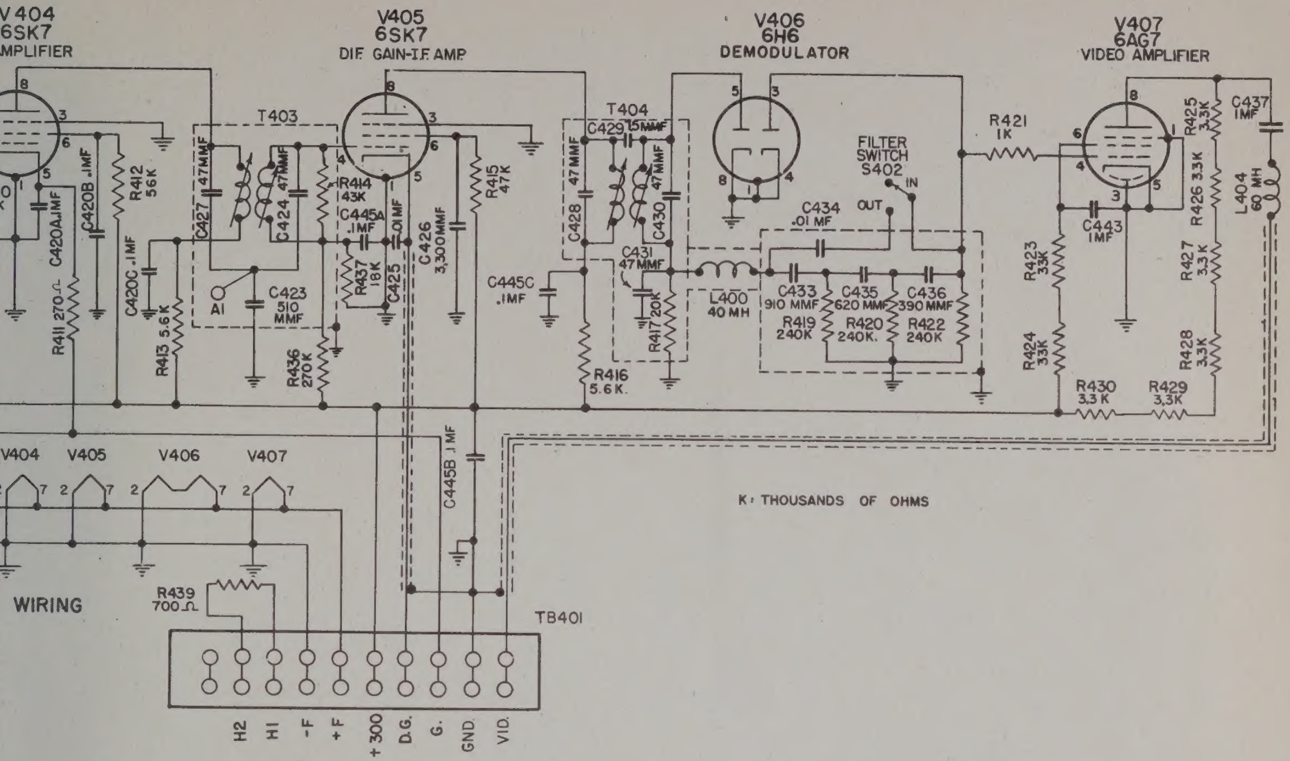
Figure 7-25—Power Supply Unit Schematic Diagram


K-THOUSANDS OF OHMS
M-MILLIONS OF OHMS
T301
L305
10 H.
5 V.A.C.
V301
5U4G
440 V.A.C.
440 V.A.C.
C301
10MF
C302
10MF
115 V.
PRI.
S302
230V.
115V.
115V.
PRI.
2.5 V.A.C.
6.3 V.A.C.
6.9 V.A.C.
FILAMENT WIRING
V302
V303
V304
I301
R318
270K
R328
390K
C305
10MF
R301
2.2K
V303
6Y6G
R303
8.2K
R324
2.2K
V302
6Y6G
R305
8.2K
R302
220K
R306
47Ω
R304
47Ω
R325
5.1K
R307
39K
R323
430K
R319
5.1K
V304
6SL7GT
C303A
0.1MF
R329
43K
VOLTAGE
CONTROL
R308 10K
R309
15K
R320
5.1K
R321
82K
C303B
0.1MF
R322
56K
V305
VR150
T302
1600 V.A.C.
V307
2X2
R317
3.9M
R316
3.9M
R315
3.9M.
R314
3.9M
R313
3.9M.
R312
3.9M
R311
3.9M.
C306
C
0.1MF
6.3 V.A.C.
2.5 V.A.C.
V306
2X2
R310
470K
C306A
0.1 MF
C306
B
0.1MF
-1800V. D.C.
+2200V. D.C.
+300V. D-C REGULATED
S301
ON
OFF
F301
C309A
.25MF
C309B
.25MF
L301
L302
C310B
.25MF
L304
L303
C310A
.25MF
POWER INPUT
J301
SPACE HEATER HERE
TB301
H1
H2
+2200 V.D.C.
-1800 V.D.C.
6.3 V. A-C
+300V.
6.3 V.A.C.
L306
6.3 V.A.C.
+300V.
TB302
+H.V.
- H.V.
C.R.T. FIL.
C.R.T. FIL
+300
+F
-F
TB401
(ON RECEIVER)
H2
H1
-F
+F
+300
D.G.
G
GND
VID.
R336
2.7K
R335
10K
F. D. RANGE
R337
10K
F.D. MIN.
R338
10K
FINE DELAY
C.D. MIN R333-10K
R330
2.7K
C.D. RANGE
R331 - 10K
R334
9.1K
COURSE DELAY
R332 -10K
TB303
D1
D2
D3
D4
D5
VID
G
DG
H3
H4
SPACE HEATER LINE

SYM.	DESCRIPTION
	UNLESS OTHERWISE SPECIFIED ALL
	RESISTORS ARE INSULATED CARBON
R301	RESISTOR 2200 Ω ±10% ½ W.
R302	220,000Ω ± 5 % 1W.
R303	8,200 Ω ±10% ½ W
R304	47 Ω ±10 % 1 W.
R305	8,200 Ω ±10% ½ W.
R306	47 Ω ±10% 1W.
R307	RESISTOR 39000 Ω ±5% 1 W.
R308	POTENTIOMETER 10,000 Ω ±10% WW
R309	RESISTOR 15,000 Ω ± 5 % 1W
R310	470,000 Ω ±10% 1W
R311	3.9 MEG Ω ±10% 1W
R312	3.9 MEG Ω ± 10% 1W
R313	3.9 MEG Ω ±10% 1W
R314	3.9 MEG Ω ±10% 1W
R315	3.9 MEG. Ω ±10% 1W
R316	3.9 MEG. Ω ±10% 1W
R317	3.9 MEG Ω ±10% 1W
R318	270,000 Ω ±10% 1W
R319	5,100 Ω ±5% 1W
R320	5,100 Ω ±5% 1W
R321	82,000 ±5% ½ W
R322	56,000 Ω ±5% ½ W.
R323	430,000 Ω ±5% 1W.
R324	2,200 Ω ±10% ½ W.
R325	RESISTOR 5,100 Ω ± 5% 1W.
R326	
R327	
R328	RESISTOR 390,000 Ω ±10% 1W.
R329	RESISTOR 43,000 Ω ±5% 1W.
R330	RESISTOR 2700 Ω ± 5 % 1 W.
R331	POTENTIOMETER 10,000 Ω ±10% WW 2W
R332	POTENTIOMETER 10,000 Ω ±5% WW 4W
R333	POTENTIOMETER 10,000 Ω ±10% WW 2W
R334	RESISTOR 9,100 Ω ±5% 1W
R335	POTENTIOMETER 10,000 Ω ±10% WW 2W
R336	RESISTER 2,700 Ω ± 5 % 1W.
R337	POTENTIOMETER 10,000 Ω ±10% WW 2W
R338	POTENTIOMETER 10,000 Ω ± 5 % 4 W
C301	CAPACITOR - PAPER 10 MFD ±10% 1000V.
C302	10 MFD ±10% 600 V.
C303	(A) 0.1 MFD ±15 % 600V.
C303	(B) 0.1 MFD ± 15% 600V
C305	10 MFD ±10% 600V
C306	(A) 0.1 MFD ± 10% 3000V.
C306	(B) 0.1 MFD ±10% 3000V.
C306	(C) 0.1 MFD ± 10% 3000V.
C309	(A) 0.25 MFD ±20% 600V
C309	(B) 0.25 MFD ±20% 600V
C310	(A) 0.25 MFD ±20% 600
C310B	CAPACITOR PAPER 0.25 MFD ±20% 600V.
F301	FUSE FOR 115V 5A LITTLE FUSE 1094 OR EQUIV.
	FUSE FOR 230V - 2.0A LITTLE FUSE 1094 OR EQUIV.
L301	FILTER COIL (LINE)
L302	
L303	
L304	FILTER COIL (LINE)
L305	FILTER REACTOR - 10 HY. 180 MA.
L306	FILAMENT CHOKE

SYM	DESCRIPTION
PL301	CONNECTOR RECEPTACLE
S301	SWITCH - D.P.D.T. TOGGLE "ON" "OFF"
S302	SWITCH - D.P.D.T. 115V - 230V.
T301	TRANSFORMER - POWER
T302	TRANSFORMER - H.V.
TB301	JUNCTION BOARD
TB302	TERMINAL BOARD HIGH VOLTAGE
TB303	TERMINAL BOARD LOW VOLTAGE
V301	TUBE 5U4G RECTIFIER
V302	6Y6G REGULATOR
V303	6Y6G REGULATOR
V304	6SL7GT REG. AMPLIFIER
V305	VR 150 VOLTAGE REG.
V306	2 X 2 H.V. RECTIFIER
V307	TUBE 2 X 2 H.V. RECTIFIER

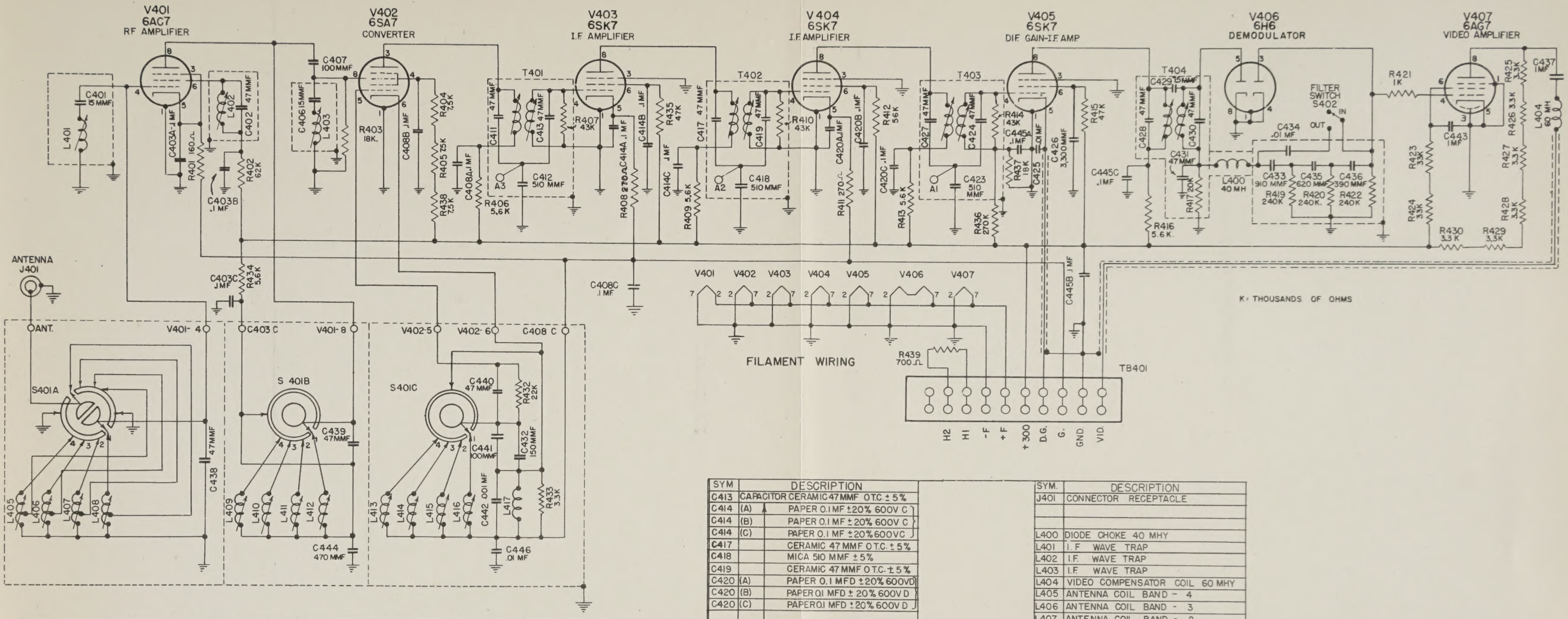
Figure 7-25—Power Supply Unit Schematic Diagram


V404
6SK7
MPLIFIER
V405
6SK7
DIF. GAIN-I.F. AMP.
V406
6H6
DEMODULATOR
V407
6AG7
VIDEO AMPLIFIER
T403
T404
C429 7.5MMF
C427 47MMF
47MMF
C424
R414 43K
C445A .1MF
C426 3,300MMF
R415 47K
C425 .01MF
R437 18K
C428 47MMF
C430 47MMF
C431 47MMF
C445C .1MF
R417 20K
R416 5.6K.
L400 40 MH
FILTER SWITCH S402
OUT
IN
C434 .01 MF
C433 910 MMF
C435 620 MMF
C436 390 MMF
R419 240K
R420 240K.
R422 240K
R421 1K
C443 1MF
R423 33K
R424 33K
R425 3.3K
R426 3.3K
R427 3.3K
R428 3.3K
R429 3.3K
R430 3.3 K
C437 1MF
L404 60 MH
C420A .1MF
C420B .1MF
C420C .1MF
R411 270Ω
R412 56K
R413 5.6K
R436 270K
C423 510 MMF
A1
C445B .1MF
V404
V405
V406
V407
R439 700Ω
WIRING
TB401
H2
H1
-F
+F
+300
D.G.
G.
GND
VID.
K: THOUSANDS OF OHMS

SCRIPTION
AMIC 47MMF OT.C. ± 5%
ER 0.1 MF ±20% 600V C
ER 0.1 MF ± 20% 600V C
R 0.1 MF ±20% 600VC
AMIC 47 MMF OT.C. ± 5%
510 MMF ± 5%
AMIC 47 MMF OT.C. ± 5%
ER 0.1 MFD ±20% 600VD
R 0.1 MFD ± 20% 600V D
R 0.1 MFD ± 20% 600V D
510 MMF ±5%
AMIC 47 MMF OT.C. ±5%
R .01 MF ±20 % 400V.
3,300 MMF ±10%
AMIC 47MMFD OTC. ±5%
MIC 47MMFD OTC. ±5%
MIC 7.5 MMFD ±5% O.T.C.
AMIC 47 MMF OT.C. ±5%
AMIC 47 MMF OT.C. ±5%
AMIC 150 MMF ±5%
A 910 MMF ±5% 300V.
PER .01 MF ±20% 400V.
A 620 MMF ±5% 300V.
A 390 MMF ± 5 %
R 1 MF ±10% 500V.
AMIC 47 MMF OT.C. ± 5%
MIC 47 MMF OT.C. ± 5%
MIC 47 MMF OT.C. ± 5%
AMIC 100 MMF ± 5 %
A 1,000 MMF ±5% 300V.
R 1 MFD ± 10% 500V.
470 MMF ±10% 500V.
R 0.1 MFD ±20% 600V.E
R 0.1 MFD ± 20% 600VE
R 0.1 MFD ± 20% 600VE
R .01 MF ± 20% 400V
TER
IFIER
IFIER
- I.F. AMP.
LATOR
MPLIFIER

SYM.	DESCRIPTION
J401	CONNECTOR RECEPTACLE
L400	DIODE CHOKE 40 MHY
L401	I.F. WAVE TRAP
L402	I.F. WAVE TRAP
L403	I.F. WAVE TRAP
L404	VIDEO COMPENSATOR COIL 60 MHY
L405	ANTENNA COIL BAND - 4
L406	ANTENNA COIL BAND - 3
L407	ANTENNA COIL BAND - 2
L408	ANTENNA COIL BAND - 1
L409	CONVERTER COIL - BAND - 4
L410	CONVERTER COIL - BAND - 3
L411	CONVERTER COIL - BAND - 2
L412	CONVERTER COIL - BAND - 1
L413	OSCILLATOR COIL - BAND - 4
L414	OSCILLATOR COIL - BAND - 3
L415	OSCILLATOR COIL - BAND - 2
L416	OSCILLATOR COIL - BAND - 1
L417	OSCILLATOR COIL -CHOKE
S401A	ANTENNA BAND SWITCH
S401B	CONVERTER BAND SWITCH
S401C	OSCILLATOR BAND SWITCH
S402	FILTER SWITCH
T401	I.F. TRANSFORMER
T402	I.F. TRANSFORMER
T403	I.F. TRANSFORMER
T404	I.F. TRANSFORMER

Figure 7-26—Receiver Unit Schematic Diagram



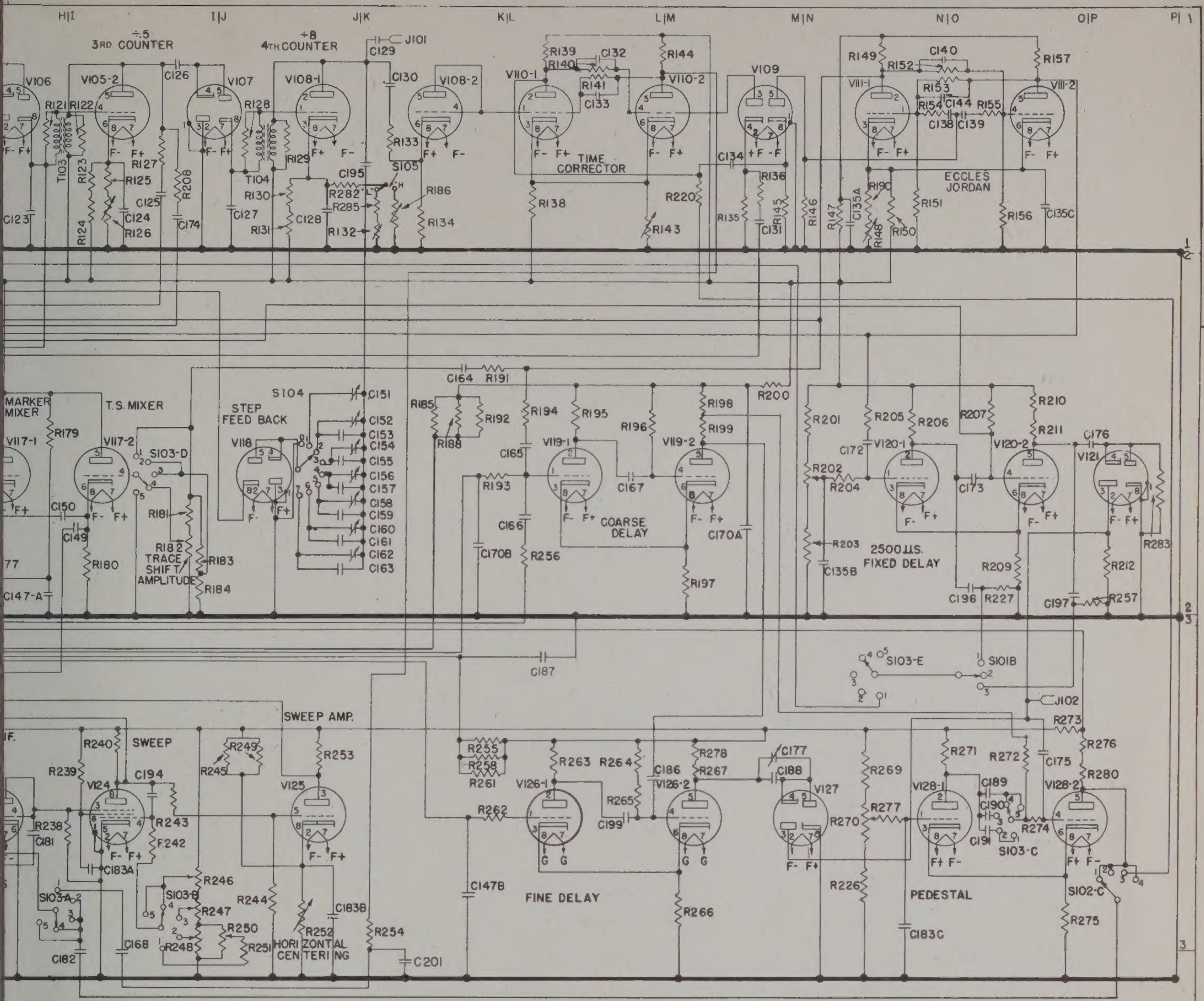
SYM.	DESCRIPTION
	UNLESS OTHERWISE SPECIFIED ALL
	RESISTORS INSULATED CARBON TYPE.
R401	RESISTOR 160 Ω ±5% ½ W.
R402	62,000 Ω ±5% 1W.
R403	18,000 Ω ±5% ½ W.
R404	7,500 Ω ±5% 1W.
R405	7,500 Ω ±5% 1W.
R406	5,600 Ω ±10% 1W.
R407	43,000 Ω ±5% ½ W.
R408	270 Ω ±5% ½ W.
R409	5,600 Ω ±10% 1W.
R410	43,000 Ω ±5% ½ W.
R411	270 Ω ±5% ½ W.
R412	56,000 Ω ±5% 1W.
R413	5,600 Ω ±10% 1W.
R414	43,000 Ω ±5% ½ W.
R415	47,000 Ω ±5% 1W.
R416	5,600 Ω ±10% 1W.
R417	20,000 Ω ±5% ½ W.
R418	
R419	240,000 Ω ±5% ½ W.
R420	240,000 Ω ±5% ½ W.
R421	1000 Ω ±10% ½ W.
R422	240,000 Ω ±5% ½ W.
R423	RESISTOR 33,000 Ω ±10% 1W.

SYM.		DESCRIPTION
R424	RESISTOR	33,000 Ω ±10% 1W.
R425		3,300 Ω ±5% 1W.
R426		3,300 Ω ±5% 1W.
R427		3,300 Ω ±5% 1W.
R428		3,300 Ω ±5% 1W.
R429		3,300 Ω ±5% 1W.
R430		3,300 Ω ±5% 1W.
R431		
R432		22,000 Ω ±5% ½ W.
R433		3,300 Ω ±5% 1W.
R434		5,600 Ω ±10% 1W.
R435		47,000 Ω ±5% 1W.
R436		270,000 Ω ±5% 1W.
R437		18,000 Ω ±5% ½ W.
R438		7,500 Ω ±5% 1W.
R439	RESISTOR	700 Ω ±10% 30W. W.W.
C401	CAPACITOR	CERAMIC 15 MMF 0T.C. ±5%
C402		CERAMIC 47 MMF 0T.C. ±5%
C403	(A)	PAPER 0.1 MF ±20% 600V A
C403	(B)	PAPER 0.1 MF ±20% 600V A
C403	(C)	PAPER 0.1 MF ±20% 600V A
C406		CERAMIC 15 MMF 0T.C. ±5%
C407		MICA 100 MMF ±5% 500V.
C408	(A)	PAPER 0.1 MF ±20% 600V B
C408	(B)	PAPER 0.1 MF ±20% 600V B
C408	(C)	PAPER 0.1 MF ±20% 600V B
C411		CERAMIC 47 MMF 0 T.C. ±5%
C412	CAPACITOR	MICA 510 MMF ±5%

SYM		DESCRIPTION
C413	CAPACITOR	CERAMIC 47 MMF 0T.C. ±5%
C414	(A)	PAPER 0.1 MF ±20% 600V C
C414	(B)	PAPER 0.1 MF ±20% 600V C
C414	(C)	PAPER 0.1 MF ±20% 600V C
C417		CERAMIC 47 MMF 0T.C. ±5%
C418		MICA 510 MMF ±5%
C419		CERAMIC 47 MMF 0T.C. ±5%
C420	(A)	PAPER 0.1 MFD ±20% 600V D
C420	(B)	PAPER 0.1 MFD ±20% 600V D
C420	(C)	PAPER 0.1 MFD ±20% 600V D
C423		MICA 510 MMF ±5%
C424		CERAMIC 47 MMF 0T.C. ±5%
C425		PAPER .01 MF ±20% 400V.
C426		MICA 3,300 MMF ±10%
C427		CERAMIC 47 MMFD 0T.C. ±5%
C428		CERAMIC 47 MMFD 0T.C. ±5%
C429		CERAMIC 7.5 MMFD ±5% 0.T.C.
C430		CERAMIC 47 MMF 0T.C. ±5%
C431		CERAMIC 47 MMF 0T.C. ±5%
C432		CERAMIC 150 MMF ±5%
C433		S.MICA 910 MMF ±5% 300V.
C434		M.PAPER .01 MF ±20% 400V.
C435		S.MICA 620 MMF ±5% 300V.
C436		S.MICA 390 MMF ±5%
C437		PAPER 1 MF ±10% 500V.
C438		CERAMIC 47 MMF 0T.C. ±5%
C439		CERAMIC 47 MMF 0T.C. ±5%
C440		CERAMIC 47 MMF 0T.C. ±5%
C441		CERAMIC 100 MMF ±5%
C442		S.MICA 1,000 MMF ±5% 500V.
C443		PAPER 1 MFD ±10% 500V.
C444		MICA 470 MMF ±10% 500V.
C445	(A)	PAPER 0.1 MFD ±20% 600V.E
C445	(B)	PAPER 0.1 MFD ±20% 600V E
C445	(C)	PAPER 0.1 MFD ±20% 600V E
C446	CAPACITOR	PAPER .01 MF ±20% 400V
V401	TUBE	R.F. AMP.
V402		CONVERTER
V403		I.F. AMPLIFIER
V404		I.F. AMPLIFIER
V405		DIF. GAIN - I.F. AMP.
V406		DEMODULATOR
V407	TUBE	VIDEO AMPLIFIER

SYM.	DESCRIPTION
J401	CONNECTOR RECEPTACLE
L400	DIODE CHOKE 40 MHY
L401	I.F. WAVE TRAP
L402	I.F. WAVE TRAP
L403	I.F. WAVE TRAP
L404	VIDEO COMPENSATOR COIL 60 MHY
L405	ANTENNA COIL BAND - 4
L406	ANTENNA COIL BAND - 3
L407	ANTENNA COIL BAND - 2
L408	ANTENNA COIL BAND - 1
L409	CONVERTER COIL - BAND - 4
L410	CONVERTER COIL - BAND - 3
L411	CONVERTER COIL - BAND - 2
L412	CONVERTER COIL - BAND - 1
L413	OSCILLATOR COIL - BAND - 4
L414	OSCILLATOR COIL - BAND - 3
L415	OSCILLATOR COIL - BAND - 2
L416	OSCILLATOR COIL - BAND - 1
L417	OSCILLATOR COIL -CHOKE
S401A	ANTENNA BAND SWITCH
S401B	CONVERTER BAND SWITCH
S401C	OSCILLATOR BAND SWITCH
S402	FILTER SWITCH
T401	I.F. TRANSFORMER
T402	I.F. TRANSFORMER
T403	I.F. TRANSFORMER
T404	I.F. TRANSFORMER

Figure 7-26—Receiver Unit Schematic Diagram



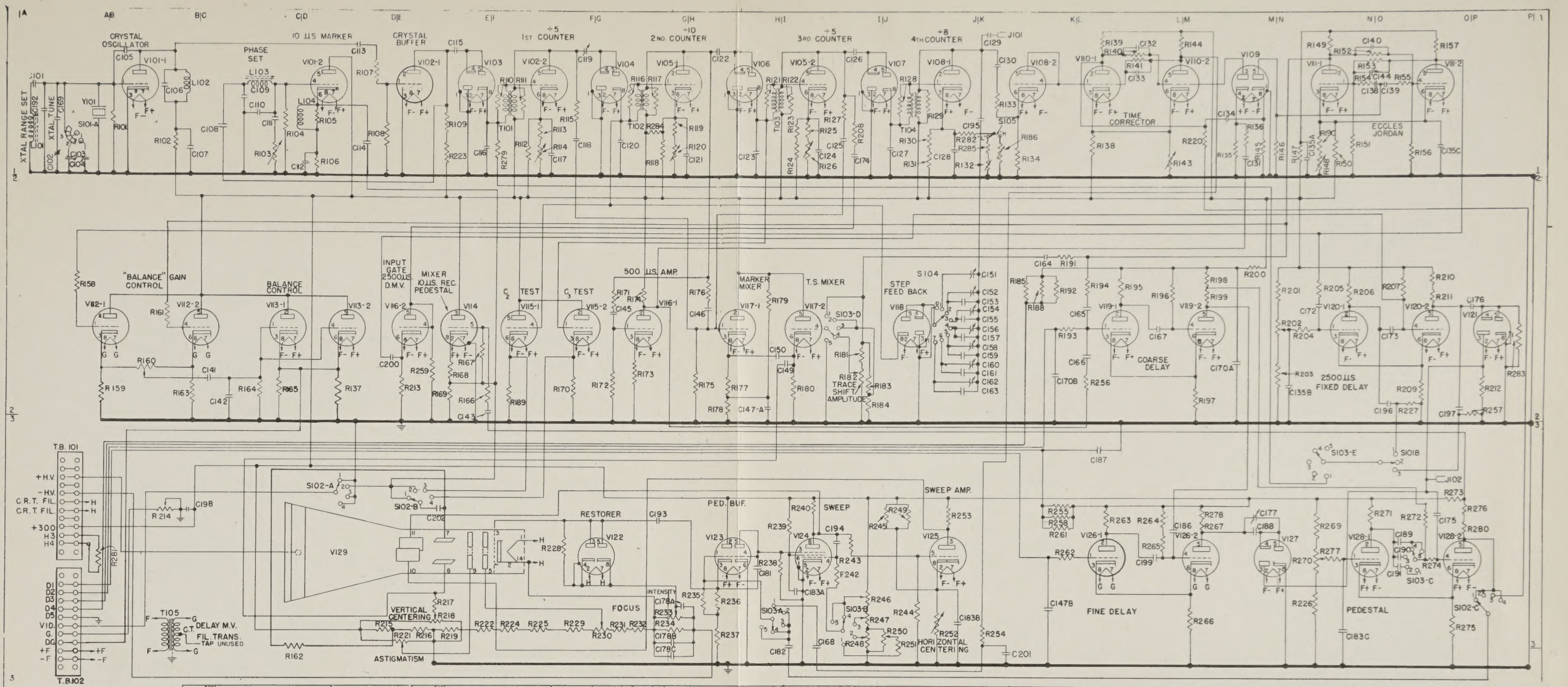
SYMBOL	[illegible]	DESCRIPTION
R185	K2	RES. 200,000 Ω ±5% 1W
R186	K1	POT W W 10000 Ω ± 10%
R187		
R188	K2	200,000 Ω ±5% 1W.
R189	F2	56,000 Ω ±10% 1W
R190	N1	3,900 Ω ±5% 1W
R191	K2	82,000 Ω ±10% 1/2 W.
R192	K2	200,000 Ω ±5% 1W
R193	L2	100,000 Ω ±10% 1/2 W.
R194	L2	33,000 Ω ±10% 1/2 W
R195	L2	20,000 Ω ±5% 1W
R196	L2	3.3 MEG Ω ±5% 1W
R197	M2	12,000 Ω ±5% 1W
R198	M2	10,000 Ω ±5% 1W
R199	M2	10,000 Ω ±5% 1W
R200	M2	2,200 Ω ±10% 1W
R201	N2	RES. 220,000 Ω ±5% 1W
R202	N2	POT. W.W. 10,000 Ω ±10%
R203	N2	RES. 10,000 Ω ±5% 1W
R204	N2	100,000 Ω ±10% 1/2 W
R205	N2	27,000 Ω ±10% 1/2 W
R206	N2	20,000 Ω ±5% 1W
R207	O2	3.9 MEG Ω ±5% 1W
R208	I1	56,000 Ω ±10% 1/2 W
R209	O2	10,000 Ω ±5% 1W
R210	O2	10,000 Ω ±5% 1W
R211	O2	10,000 Ω ±5% 1W
R212	P2	330,000 Ω ±10% 1/2 W
R213	E2	330,000 Ω ±10% 1/2 W
R214	B3	2,000-4W W.W. POT. TAP ±10%
R215	O3	330000 Ω ±10% 1/2 W
R216	E3	330,000 Ω ±10% 1W
R217	E3	RES. 1.5 MEG Ω ±10% 1/2 W
R218	E3	POT. CARBON 2.0 MEG. Ω ±20%
R219	E3	RES. 330,000 Ω ±10% 1W
R220	M1	RES. 100,000 Ω ±10% 1/2 W
R221	E3	POT. 2 MEG Ω ±20% CARBON
R222	E3	RES. 330,000 Ω ±5% 1W
R223	E1	10,000 Ω ±10% 1W
R224	F3	470,000 Ω ±5% 1W
R225	F3	470,000 Ω ±5% 1W
R226	N3	36,000 Ω ±5% 1W
R227	O2	4.7 MEG. Ω ±10% 1/2 W
R228	F3	2.7 MEG. Ω ±10% 1W
R229	F3	RES. 330,000 Ω ±5% 1W
R230	G3	POT. CARBON 750,000 Ω ±10%
R231	G3	RES. 270,000 Ω ±5% 1W
R232	G3	RES. 240,000 Ω ±5% 1W
R233	G3	POT. CARBON 500,000 Ω ±10%
R234	G3	RES. 470,000 Ω ±10% 1W
R235	H3	220,000 Ω ±10% 1/2 W
R236	H3	9,100 Ω ±5% 1/2 W
R237	H3	100,000 Ω ±10% 1W
R238	H3	2.7 MEG. Ω ±10% 1/2 W
R239	I3	68,000 Ω ±5% 1W
R240	I3	39,000 Ω ±5% 1W
R242	I3	180,000 Ω ±5% 1W
R243	I3	620,000 Ω ±5% 1W
R244	J3	43,000 Ω ±5% 1/2 W
R245	J3	RES. 180,000 Ω ±10% 1W
R246	I3	POT. CARBON 100,000 Ω ±20%

SYMBOL	[illegible]	DESCRIPTION
R247	I3	POT. CARB. 100,000 Ω ±20%
R248	I3	POT. CARB. 50,000 Ω ±20%
R249	J3	RES. 180,000 Ω ±10% 1W
R250	J3	POT. 50,000 Ω ±20% CARB.
R251	J3	RES. 3.6 MEG Ω ±5% 1/2 W
R252	J3	POT. W.W. 10,000 Ω ±10%
R253	J3	RES. 160,000 Ω ±5% 1W.
R254	K3	RES. 100,000 Ω ±10% 1/2 W.
R255	K3	RES. 200,000 Ω ±5% 1W
R256	L2	RES. 150,000 Ω ±10% 1/2 W
R257	P2	RES. 4.7 MEG Ω ±10% 1/2 W
R258	K3	RES. 200,000 Ω ±5% 1W
R259	E2	270,000 Ω ±10% 1/2 W
R261	K3	200,000 Ω ±5% 1W
R262	K3	100,000 Ω ±10% 1/2 W
R263	L3	20,000 Ω ±5% 1W
R264	L3	1.2 MEG Ω ±5% 1W
R265	L3	1.2 MEG. Ω ±5% 1W
R266	M3	10,000 Ω ±5% 1W
R267	M3	RES. 10,000 Ω ±5% 1W
R269	N3	RES. 180,000 Ω ±10% 1W
R270	N3	FCT. 10,000 Ω ±10% W.W.
R271	O3	RES. 10,000 Ω ±5% 1W
R272	O3	3.9 MEG. Ω ±5% 1W
R273	O3	2,000 Ω ±5% 1W
R274	O3	100,000 Ω ±5% 1/2 W
R275	O3	6,800 Ω ±5% 1W
R276	P3	3,600 Ω ±5% 1W
R277	N3	100,000 Ω ±10% 1/2 W
R278	M3	10,000 Ω ±5% 1W
R279	F1	560,000 Ω ±10% 1/2 W
R280	P3	4,300 Ω ±5% 1W
R281	A3	700 Ω ±10% 30 W
R282	J1	11,000 Ω ±5% 1W
R283	P2	330,000 Ω ±10% 1/2 W
R284	G1	RES. 180,000 Ω ±5% 1W
R285	K1	RES. 39,00 Ω ±5% 1W
		(NOTE -R285 ON UNITS AFTER SERIAL NO. 770 ONLY)
S105	K1	PRR SWITCH DPDT
T101	F1	BLOCKING OSC. TRANSFORMER
T102	G1	BLOCKING OSC. TRANSFORMER
T103	H1	BLOCKINC OSC. TRANSFORMER
T104	J1	BLOCKING OSC. TRANSFORMER
T105	B3	HEATER TRANSFORMER
L101	A1	OSCILLATOR GRID COIL
L102	B1	OSCILLATOR PLATE COIL 6 MHY
L103	C1	PHASE SHIFT COIL 13.5 MHY
L104	C1	PIP COIL 2 MHY
S101-A	A1	CRYSTAL FREQ. CHANGE SWITCH
S101-B	O3	FRAMING SWITCH
S102-A	D3	RECEIVER SWITCH
S102-B	E3	TEST SWITCH
S102-C	P3	SWEEP SELECTOR
S103-A	H3	SWEEP INPUT SWITCH
S103-B	I3	SWEEP SPEED SWITCH
S103-C	O3	PEDESTAL LENGTH SWITCH
S103-D	I2	TRACE SHIFT SWITCH
S103-E	N3	FRAMING INPUT SWITCH

SYMBOL	[illegible]	DESCRIPTION
S104	J2	STATION SELECTOR SWITCH
V101-1	B1	TUBE CRYSTAL OSC. 6SL7GT
V101-2	D1	10 US PIP MAKER
V102-1	E1	100 KC BUFFER 6SN7GT
V102-2	F1	1ST BLOCKING OSC.
V103	E1	1ST. COUNTER GATE 6H6GT
V104	G1	2ND. COUNTER GATE 6H6GT
V105-1	G1	2ND. BLOCKING OSC. 6SN7GT
V105-2	I1	3RD BLOCKING OSC.
V106	H1	3RD. COUNTER GATE 6H6GT
V107	I1	4TH COUNTER GATE 6H6GT
V108-1	J1	4TH BLOCKING OSC 6SN7GT
V108-2	K1	E J INPUT GATE
V109	M1	T.C.E. J. INPUT GATE 6H6GT
V110-1	L1	TIME CORRECTOR E.J. 6SN7GT
V110-2	L1	TIME CORRECTOR E J
V111-1	N1	E.J. 25 ∿ SQ WAVE MAKER 6SN7G
V111-2	O1	E.J. 25 ∿ SQ WAVE MAKER
V112-1	A2	GAIN BALANCE AMP 6SL7GT
V112-2	B2	GAIN BALANCE AMP.
V113-1	C2	GAIN BALANCE CONTROL 6SN7GT
V113-2	D2	REFERENCE DIODE
V114	E2	10 US REC. & PED MIXER 6J5GT
V115-1	F2	COUNTER TEST 6SL7GT
V115-2	F2	COUNTER TEST
V116-1	G2	500 US TIMER AMP 6SL7GT.
V116-2	E2	INPUT GATE FIXED DMV.
V117-1	H2	50, 500, 2500 µS MIXER 6SL7GT
V117-2	J2	TRACE SHIFT MIXER
V118	J2	STEP FEED BACK GATE 6H6GT
V119-1	L2	COARSE DELAY M.V. 6SN7GT
V119-2	M2	COARSE DELAY M.V.
V120-1	N2	2,500 µS FIXED DELAY M.V. 6SL
V120-2	O2	2,500 µS. FIXED DELAY M.V
V121	P2	PED. INPUT GATE 6H6GT
V122	F3	C.R. BLANKING REST. 6H6GT
V123-1	H3	SWEEP INPUT GATE 6SN7GT
V123-2	H3	SWEEP INPUT GATE
V124	I3	SWEEP GENERATOR 6SK7
V125	J3	SWEEP AMPLI. 6J5GT
V126-1	L3	FINE DELAY M.V. 6SN7GT
V126-2	M3	FINE DELAY M.V
V127	N3	PEDESTAL INPUT 6H6GT
V128-1	N3	PEDESTAL GENER. 6SN7GT
V128-2	P3	PEDESTAL GENER.
V129	D3	TUBE C.R. TUBE 5CP1
Y101	A1	100 K.C. CRYSTAL
TB101	A3	TERMINAL BOARD
TB102	A3	TERMINAL BOARD
J101	K1	JACK 50 CYCLES SYNC. OUTPUT
J102	O3	JACK SYNC. FOR TRAINER

NOTE *1 - ON DAS AND DAS-1 USE C--6SK7, PT. 232; ON DAS-2 USE C--6SJ7, PT. 230.

Figure 7-27—Indicator Unit Schematic Diagram



SWITCH	POSITION NUMBER	PANEL MARKING
S101-A, B LEFT-RIGHT	1 2	LEFT RIGHT
S103-A, B, C, D, E RECEIVER	1 2 3 4	OFF ON CAL. 1 CAL. 2

SYMBOL	LOCATION	DESCRIPTION
C101	A1	CAP MICA 3800 MMF ±5% 500 V.
C102	A1	AIR TRIMMER 50 MMFD MAX.
C103	A1	CERAMIC 1.5 MMFD O.T.C ±20%
C104	A1	CERAMIC 2.2 MMFD O.T.C. ±20%
C105	B1	CERAMIC 4.7 MMFD O.T.C ±10%
C106	B1	SILVER MICA 300 MMF ±5% 500 V
C107	B1	PAPER 6,000 MMF ±20% 600 V
C108	C1	CERAMIC 47 MMFD ±10% O.T.C.
C109	C1	MICA 390 MMFD ±5% 500 V.
C110	C1	MICA 200 MMFD ±5% 500 V
C111	C1	MICA 200 MMFD ±5% 500 V.
C112	D1	MOULDED PAPER .01 MFD ±20% 400 V
C113	D1	MICA 330 MMFD ±10% 500 V.
C114	D1	CERAMIC 47 MMF ±10% O.T.C.
C115	E1	CERAMIC 33 MMFD ±10% O.T.C.
C116	E1	MICA 510 MMFD ±5% 500 V
C117	F1	PAPER .5 MFD ±10% 600 V.
C118	F1	CERAMIC 68 MMFD O.T.C ±10%
C119	F1	AIR TRIMMER 68 MMFD MAX.
C120	G1	MICA 2,400 MMFD ±5% 500 V
C121	H1	PAPER 10 MFD ±10% 500 V
C122	H1	CERAMIC 33 MMFD O.T.C ±5%
C123	H1	MICA 2,400 MMFD ±5% 500 V
C124	I1	PAPER 1.0 MFD ±10% 500 V
C125	I1	CERAMIC 91 MMFD MAX. NEG ±5%
C126	I1	CERAMIC 43 MMFD ±5% O.T.C.
C127	J1	MICA 3,900 MMFD ±5% 500 V
C128	J1	PAPER 1.0 MFD ±10% 500 V
C129	K1	CERAMIC 100 MMFD MAX. NEG ±10%
C130	K1	CERAMIC 100 MMFD MAX. NEG ±10%
C131	M1	CERAMIC 47 MMFD ±5% O.T.C.
C132	L1	CERAMIC 240 MMF MAX. NEG ±5%
C133	L1	CERAMIC 240 MMF MAX. NEG ±5%
C134	M1	CERAMIC 240 MMFD MAX. NEG ±5%
C135A	N1	PAPER .1 MFD ±20% 600 V
C135B	N2	PAPER .1 MFD ±20% 600 V
C135C	O1	PAPER .1 MFD ±20% 600 V
C138	N1	CERAMIC 10 MMF O.T.C. ±5%
C139	O1	CERAMIC 10 MMF O.T.C. ±5%
C140	N1	CERAMIC 27 MMFD ±5% O.T.C.
C141	C2	PAPER .5 MFD ±10% 600 V
C142	C2	MICA 1,000 MMF ±10% 500 V
C143	E2	MOULDED PAPER .01 MFD ±20% 400 V
C144	N1	CERAMIC 27 MMFD ±5% O.T.C.
C145	G2	CERAMIC 27 MMF ±10% O.T.C.
C146	H2	CERAMIC 51 MMF ±5% MAX. NEG
C147A	H2	PAPER .1 MFD ±20% 600 V
C147B	K3	PAPER 2X .1 MFD ±20% 600 V
C149	I2	PAPER .5 MFD ±10% 600 V
C150	I2	MICA 390 MMFD ±5% 500 V
C151	J2	AIR 50 MMF STATION SELECTOR
C152	J2	AIR 50 MMF STATION SELECTOR
C153	J2	CERAMIC 22 MMF ±5%
C154	J2	AIR 50 MMF STATION SELECTOR
C155	J2	CERAMIC 51 MMF ±5%
C156	J2	AIR 50 MMF STATION SELECTOR
C157	J2	CERAMIC 75 MMF ±5%
C158	J2	AIR 50 MMF STATION SELECTOR
C159	J2	CERAMIC 100 MMF
C160	J2	AIR 50 MMF STATION SELECTOR
C161	J2	CERAMIC 130 MMF ±5%
C162	J2	CAP. AIR 50 MMF STATION SELECTOR
C163	J2	CAP. CERAMIC 160 MMF ±5%
C164	K2	PAPER .5 MFD ±10% 600 V
C165	L2	CERAMIC 220 MMF MAX. NEG ±10%
C166	L2	CERAMIC 47 MMF O.T.C. ±10%
C167	L2	MICA .03 MFD ±5% 600 V
C168	I3	PAPER .1 MFD ±10% 400 V
C169	A1	CERAMIC 100 MMF ±5% O.T.C.
C170A	M2	PAPER 2X .1 MFD ±20% 600 V
C170B	K2	PAPER .1 MFD ±20% 600 V.
C172	N2	CERAMIC 27 MMF O.T.C. ±10%
C173	O2	MICA .01 MFD ±5% 300 V
C174	I1	CERAMIC 47 MMF ±10% O.T.C.
C175	I1	MICA 470 MMF ±10% 500 V
C176	P2	MICA 680 MMF ±5% 500 V.
C177	M3	CERAMIC TRIMMER 125 MMF MAX.
C178A	H3	PAPER .1 MFD ±20% 600 V
C178B	H3	PAPER .1 MFD ±20% 600 V
C178C	H3	PAPER .1 MFD ±20% 600 V
C181	H3	PAPER .1 MFD ±10% 400 V
C182	I3	PAPER .1 MFD ±10% 400 V
C183A	I3	PAPER .1 MFD ±20% 600 V
C183B	J3	PAPER .1 MFD ±20% 600 V
C183C	N3	PAPER .1 MFD ±20% 600 V
C186	M3	MICA 470 MMF ±10% 500 V
C187	L3	PAPER 1.0 MFD ±10% 500 V
C188	M3	CERAMIC 110 MMF ±5% O.T.C.
C189	O3	MICA 360 MMF ±5% 500 V
C190	O3	MICA 1300 MMF ±5% 500 V
C191	O3	MICA 3,600 MMF ±5% 500 V
C192	A1	CERAMIC 51 MMF ±5% O.T.C.
C193	G3	PAPER .1 MFD 3000 V
C194	I3	MICA 1,000 MMFD 500 V ±5%
C195	K1	PAPER 6,000 MMF 20% 600 V.
C196	O2	PAPER .1 MFD ±10% 400 V
C197	O2	PAPER .1 MFD 10% 400 V.
C198	B3	PAPER 1.0 MFD 500 V ±10%
C199	L3	MICA 1,500 MMFD ±5% 500 V
C200	O2	CAP. MICA 470 MMF ±10% 500 V
C201	K3	CAP. MICA 470 MMF. ±10% 500 V
C202	E3	CAP. PAPER .1 MFD ±10% 400 V
R101	B1	RES. 120,000 Ω ±10% 1/2 W
R102	B1	RES. 2,200 Ω ±10% 1 W
R103	C1	POT. 2 MEG ±20% TAPERED
R104	C1	RES. 1 MEG Ω ±10% 1/2 W
R105	D1	750 Ω ±5% 1/2 W
R106	D1	22,000 Ω ±10% 1 W
R107	D1	39,000 Ω ±10% 1/2 W
R108	D1	100,000 Ω ±10% 1/2 W
R109	E1	10,000 Ω ±10% 1 W
R110	E1	11,000 Ω ±5% 1 W
R111	F1	4,700 Ω ±5% 1 W
R112	F1	180,000 Ω ±5% 1 W
R113	F1	RES. 1,000 Ω ±10% 1 W
R114	F1	POT. W.W. 10,000 Ω ±10% 2 W
R115	F1	RES. 30,000 Ω ±5% 1/2 W
R116	G1	11,000 Ω ±5% 1 W
R117	G1	4,700 Ω ±5% 1 W
R118	G1	150,000 Ω ±10% 1 W
R119	G1	RES. 8,200 Ω ±10% 1 W
R120	G1	POT. W.W. 10,000 Ω ±10% 2 W
R121	H1	RES. 11,000 Ω ±5% 1 W
R122	I1	RES. 4,700 Ω ±5% 1 W
R123	I1	RES. 36,000 Ω ±5% 1 W.
R124	I1	RES. 39,000 Ω ±5% 1 W.
R125	I1	RES. 8,200 Ω ±10% 1 W.
R126	I1	POT. W.W. 10,000 Ω ±10% 2 W.
R127	I1	RES. 15,000 Ω ±10% 1/2 W
R128	J1	RES. 11,000 Ω ±5% 1 W.
R129	J1	RES. 4,700 Ω ±5% 1 W.
R130	J1	RES. 39,000 Ω ±10% 1 W
R131	J1	RES. 33,000 Ω ±10% 1 W
R132	J1	POT. W.W. 10,000 Ω ±10% 2 W.
R133	K1	RES. 22,000 Ω ±10% 1/2 W.
R134	K1	91,000 Ω ±5% 1/2 W
R135	M1	91,000 Ω ±5% 1/2 W
R136	M1	100,000 Ω ±10% 1/2 W
R137	D2	4,700 Ω ±10% 1 W
R138	L1	180,000 Ω ±5% 1 W
R139	L1	39,000 Ω ±5% 1 W
R140	L1	390,000 Ω ±5% 1/2 W
R141	L1	390,000 Ω ±5% 1/2 W
R143	L1	POT. 10,000 Ω ±10% 4 W W.W.
R144	L1	RES. 39,000 Ω ±5% 1 W
R145	M1	RES. 150,000 Ω ±10% 1/2 W
R146	M1	RES. 150,000 Ω ±10% 1/2 W
R147	N1	RES. 2,200 Ω ±10% 1 W
R148	N1	POT. 5,000 Ω ±10% 2 W. W.W.
R149	N1	RES. 39,000 Ω ±5% 1 W
R150	N1	160,000 Ω ±5% 1 W
R151	N1	91,000 Ω ±5% 1/2 W
R152	N1	390,000 Ω ±5% 1/2 W
R153	N1	390,000 Ω ±5% 1/2 W
R154	N1	33,000 Ω ±10% 1/2 W
R155	O1	33,000 Ω ±10% 1/2 W
R156	O1	91,000 Ω ±5% 1/2 W
R157	O1	39,000 Ω ±5% 1 W
R158	A2	1.5 MEG Ω ±10% 1/2 W
R159	A2	RES. 470,000 Ω ±10% 1 W
R160	B2	POT. CARBON 500,000 Ω ±20%
R161	B2	RES. 1.5 MEG. Ω ±10% 1/2 W
R162		1 MEG Ω ±10% 1/2 W
R163	B2	RES. 470,000 Ω ±10% 1 W
R164	C2	2.7 MEG Ω ±10% 1/2 W
R165	C2	4700 Ω ±5% 1 W
R166	E2	100,000 Ω ±10% 1/2 W
R167	E2	2.7 MEG Ω ±10% 1/2 W
R168	E2	39,000 Ω ±10% 1 W
R169	E2	180,000 Ω ±10% 1 W
R170	F2	56,000 Ω ±10% 1 W
R171	G2	100,000 Ω ±10% 1/2 W
R172	G2	56,000 Ω ±10% 1/2 W
R173	G2	4,700 Ω ±10% 1/2 W
R174	G2	22,000 Ω ±10% 1 W
R175	H2	100,000 Ω ±10% 1/2 W
R176	H2	24,000 Ω ±5% 1/2 W
R177	H2	4,700 Ω ±5% 1 W
R178	H2	12,000 Ω ±10% 1 W
R179	H2	240,000 Ω ±5% 1 W
R180	I2	100,000 Ω ±10% 1 W
R181	I2	RES. 1 MEG Ω ±10% 1/2 W
R182	I2	POT. 2 MEG Ω ±20%
R183	I2	RES. 1.2 MEG Ω ±5% 1/2 W
R184	I2	RES. 1.6 MEG Ω ±5% 1/2 W
R185	K2	RES. 200,000 Ω ±5% 1 W
R186	K1	POT W.W. 10000 Ω ±10%
R187		
R188	K2	200,000 Ω ±5% 1 W
R189	F2	56,000 Ω ±10% 1 W
R190	N1	3,900 Ω ±5% 1 W
R191	K2	82,000 Ω ±10% 1/2 W.
R192	K2	200,000 Ω ±5% 1 W
R193	L2	100,000 Ω ±10% 1/2 W.
R194	L2	33,000 Ω ±10% 1/2 W
R195	L2	20,000 Ω ±5% 1 W
R196	L2	3.3 MEG Ω ±5% 1 W
R197	M2	12,000 Ω ±5% 1 W
R198	M2	10,000 Ω ±5% 1 W
R199	M2	10,000 Ω ±5% 1 W
R200	M2	2,200 Ω ±10% 1 W
R201	N2	RES. 220,000 Ω ±5% 1 W
R202	N2	POT. W.W. 10,000 Ω ±10%
R203	N2	RES. 10,000 Ω ±5% 1 W
R204	N2	100,000 Ω ±10% 1/2 W
R205	N2	27,000 Ω ±10% 1/2 W
R206	N2	20,000 Ω ±5% 1 W
R207	O2	3.9 MEG Ω ±5% 1 W
R208	I1	56,000 Ω ±10% 1/2 W
R209	O2	10,000 Ω ±5% 1 W
R210	O2	10,000 Ω ±5% 1 W
R211	O2	10,000 Ω ±5% 1 W
R212	P2	330,000 Ω ±10% 1/2 W
R213	E2	330,000 Ω ±10% 1/2 W
R214	B3	2,000-4 W W.W. POT. TAP ±10%
R215	D3	330,000 Ω ±10% 1/2 W
R216	E3	330,000 Ω ±10% 1 W
R217	E3	RES. 1.5 MEG Ω ±10% 1/2 W
R218	E3	POT. CARBON 2.0 MEG. Ω ±20%
R219	E3	RES. 330,000 Ω ±10% 1 W
R220	M1	RES. 100,000 Ω ±10% 1/2 W
R221	E3	POT. 2 MEG Ω ±20% CARBON
R222	E3	RES. 330,000 Ω ±5% 1 W
R223	E1	10,000 Ω ±10% 1 W
R224	F3	470,000 Ω ±5% 1 W
R225	F3	470,000 Ω ±5% 1 W
R226	N3	36,000 Ω ±5% 1 W
R227	O2	4.7 MEG. Ω ±10% 1/2 W
R228	F3	2.7 MEG. Ω ±10% 1 W
R229	F3	RES. 330,000 Ω ±5% 1 W
R230	G3	POT. CARBON 750,000 Ω ±10%
R231	G3	RES. 270,000 Ω ±5% 1 W
R232	G3	RES. 240,000 Ω ±5% 1 W
R233	G3	POT. CARBON 500,000 Ω ±10%
R234	G3	RES. 470,000 Ω ±10% 1 W
R235	H3	220,000 Ω ±10% 1/2 W
R236	H3	9,100 Ω ±5% 1/2 W
R237	H3	100,000 Ω ±10% 1 W
R238	H3	2.7 MEG. Ω ±10% 1/2 W
R239	I3	68,000 Ω ±5% 1 W
R240	I3	39,000 Ω ±5% 1 W
R242	I3	180,000 Ω ±5% 1 W
R243	I3	620,000 Ω ±5% 1 W
R244	J3	43,000 Ω ±5% 1/2 W
R245	J3	RES. 180,000 Ω ±10% 1 W
R246	I3	POT. CARBON 100,000 Ω ±20%
R247	I3	POT. CARB. 100,000 Ω ±20%
R248	I3	POT. CARB. 50,000 Ω ±20%
R249	J3	RES. 180,000 Ω ±10% 1 W
R250	J3	POT. 50,000 Ω ±20% CARB.
R251	J3	RES. 3.6 MEG Ω ±5% 1/2 W
R252	J3	POT. W.W. 10,000 Ω ±10%
R253	J3	RES. 160,000 Ω ±5% 1 W.
R254	K3	RES. 100,000 Ω ±10% 1/2 W.
R255	K3	RES. 200,000 Ω ±5% 1 W
R256	L2	RES. 150,000 Ω ±10% 1/2 W
R257	P2	RES. 4.7 MEG Ω ±10% 1/2 W
R258	K3	RES. 200,000 Ω ±5% 1 W
R259	E2	270,000 Ω ±10% 1/2 W
R261	K3	200,000 Ω ±5% 1 W
R262	K3	100,000 Ω ±10% 1/2 W
R263	L3	20,000 Ω ±5% 1 W
R264	L3	1.2 MEG Ω ±5% 1 W
R265	L3	1.2 MEG Ω ±5% 1 W
R266	M3	10,000 Ω ±5% 1 W
R267	M3	RES. 10,000 Ω ±5% 1 W
R269	N3	RES. 180,000 Ω ±10% 1 W
R270	N3	POT. 10,000 Ω ±10% W.W.
R271	O3	RES. 10,000 Ω ±5% 1 W
R272	O3	3.9 MEG Ω ±5% 1 W
R273	O3	2,000 Ω ±5% 1 W
R274	O3	100,000 Ω ±5% 1/2 W
R275	O3	6,800 Ω ±5% 1 W
R276	P3	3,600 Ω ±5% 1 W
R277	N3	100,000 Ω ±10% 1/2 W
R278	M3	10,000 Ω ±5% 1 W
R279	F1	560,000 Ω ±10% 1/2 W
R280	P3	4,300 Ω ±5% 1 W
R281	A3	700 Ω ±10% 30 W
R282	J1	11,000 Ω ±5% 1 W
R283	P2	330,000 Ω ±10% 1/2 W
R284	G1	RES. 180,000 Ω ±5% 1 W
R285	K1	RES. 39,00 Ω ±5% 1 W
		(NOTE - R285 ON UNITS AFTER SERIAL NO. 770 ONLY)
S105	K1	PRR SWITCH DPDT
T101	F1	BLOCKING OSC. TRANSFORMER
T102	G1	BLOCKING OSC. TRANSFORMER
T103	H1	BLOCKING OSC. TRANSFORMER
T104	J1	BLOCKING OSC. TRANSFORMER
T105	B3	HEATER TRANSFORMER
L101	A1	OSCILLATOR GRID COIL
L102	B1	OSCILLATOR PLATE COIL 6 MHY
L103	C1	PHASE SHIFT COIL 13.5 MHY
L104	C1	PIP COIL 2 MHY
S101-A	A1	CRYSTAL FREQ. CHANGE SWITCH
S101-B	O3	FRAMING SWITCH
S102-A	D3	RECEIVER SWITCH
S102-B	E3	TEST SWITCH
S102-C	P3	SWEEP SELECTOR
S103-A	H3	SWEEP INPUT SWITCH
S103-B	I3	SWEEP SPEED SWITCH
S103-C	O3	PEDESTAL LENGTH SWITCH
S103-D	I2	TRACE SHIFT SWITCH
S103-E	N3	FRAMING INPUT SWITCH
S104	J2	STATION SELECTOR SWITCH
V101-1	B1	TUBE CRYSTAL OSC. 6SL7GT
V101-2	D1	10 US PIP MAKER
V102-1	E1	100 KC BUFFER 6SN7GT
V102-2	F1	1ST BLOCKING OSC.
V103	E1	1ST COUNTER GATE 6H6GT
V104	G1	2ND COUNTER GATE 6H6GT
V105-1	G1	2ND BLOCKING OSC. 6SN7GT
V105-2	I1	3RD BLOCKING OSC.
V106	H1	3RD. COUNTER GATE 6H6GT
V107	I1	4TH COUNTER GATE 6H6GT
V108-1	J1	4TH BLOCKING OSC. 6SN7GT
V108-2	K1	E.J. INPUT GATE
V109	M1	T.C.E. J. INPUT GATE 6H6GT
V110-1	L1	TIME CORRECTOR E.J. 6SN7GT
V110-2	L1	TIME CORRECTOR E.J.
V111-1	N1	E.J. 25 US SQ. WAVE MAKER 6SN7GT
V111-2	O1	E.J. 25 US SQ. WAVE MAKER
V112-1	A2	GAIN BALANCE AMP. 6SL7GT
V112-2	B2	GAIN BALANCE AMP.
V113-1	C2	GAIN BALANCE CONTROL 6SN7GT
V113-2	D2	REFERENCE DIODE
V114	E2	10 US REC. & PED. MIXER 6J5GT
V115-1	F2	COUNTER TEST 6SL7GT
V115-2	F2	COUNTER TEST
V116-1	G2	500 US TIMER AMP. 6SL7GT.
V116-2	E2	INPUT GATE FIXED DMV.
V117-1	H2	50, 500, 2500 µS MIXER 6SL7GT
V117-2	J2	TRACE SHIFT MIXER
V118	J2	STEP FEED BACK GATE 6H6GT
V119-1	L2	COARSE DELAY M.V. 6SN7GT
V119-2	M2	COARSE DELAY M.V.
V120-1	N2	2,500 µS FIXED DELAY M.V. 6SL
V120-2	D2	2,500 µS FIXED DELAY M.V.
V121	P2	PED. INPUT GATE 6H6GT
V122	F3	C.R. BLANKING REST. 6H6GT
V123-1	H3	SWEEP INPUT GATE 6SN7GT
V123-2	H3	SWEEP INPUT GATE
V124	I3	SWEEP GENERATOR 6SK7
V125	J3	SWEEP AMPLI. 6J5GT
V126-1	L3	FINE DELAY M.V. 6SN7GT
V126-2	M3	FINE DELAY M.V.
V127	N3	PEDESTAL INPUT 6H6GT
V128-1	N3	PEDESTAL GENER. 6SN7GT
V128-2	P3	PEDESTAL GENER.
V129	O3	TUBE CR TUBE 5CP1
Y101	A1	100 K.C. CRYSTAL
TB101	A3	TERMINAL BOARD
TB102	A3	TERMINAL BOARD
J101	K1	JACK 50 CYCLES SYNC OUTPUT
J102	O3	JACK SYNC FOR TRAINER

NOTE *1- ON DAS AND DAS-1 USE C--6SK7, PT.232; ON DAS-2 USE C--6SJ7, PT.230.

Figure 7-27—Indicator Unit Schematic Diagram

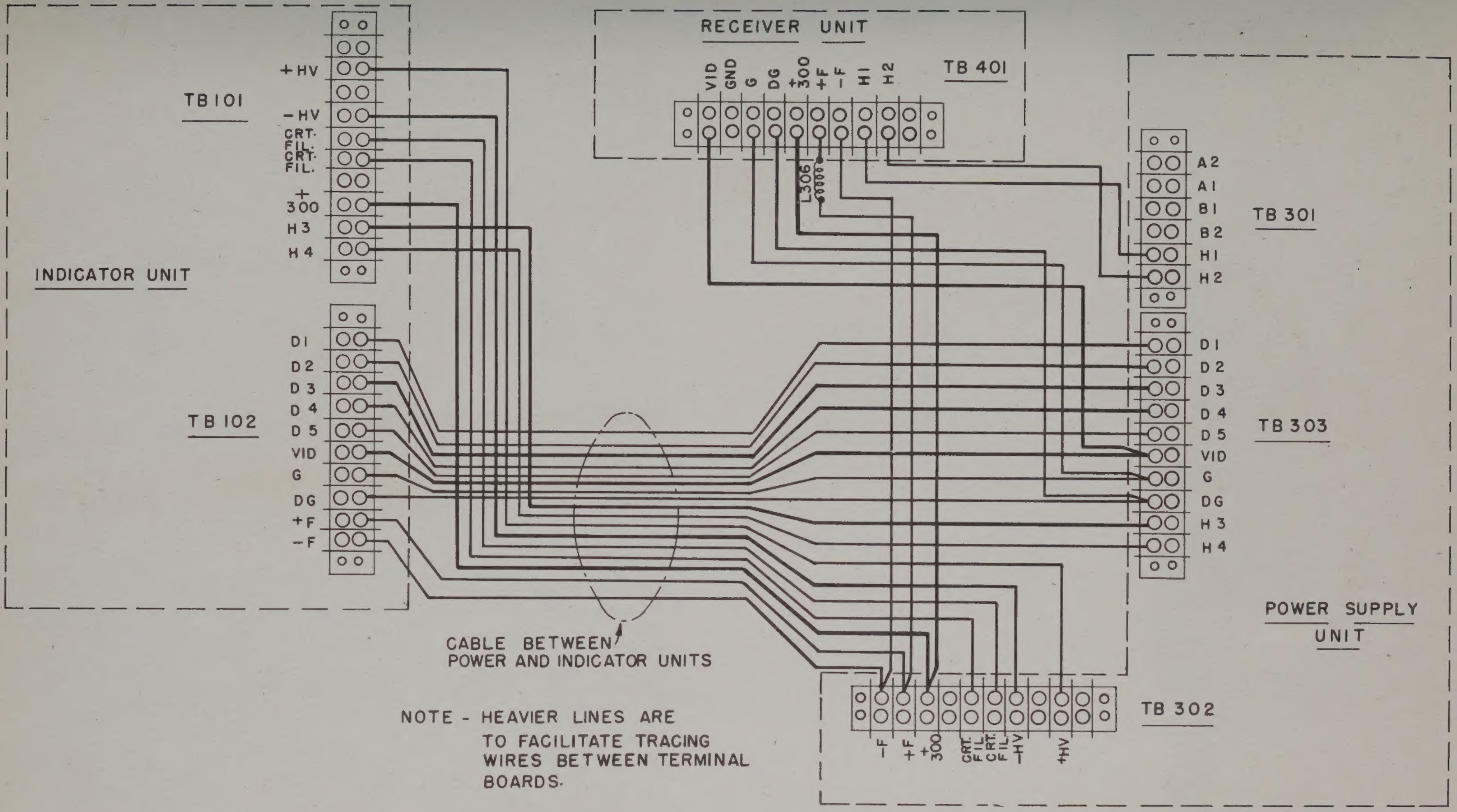
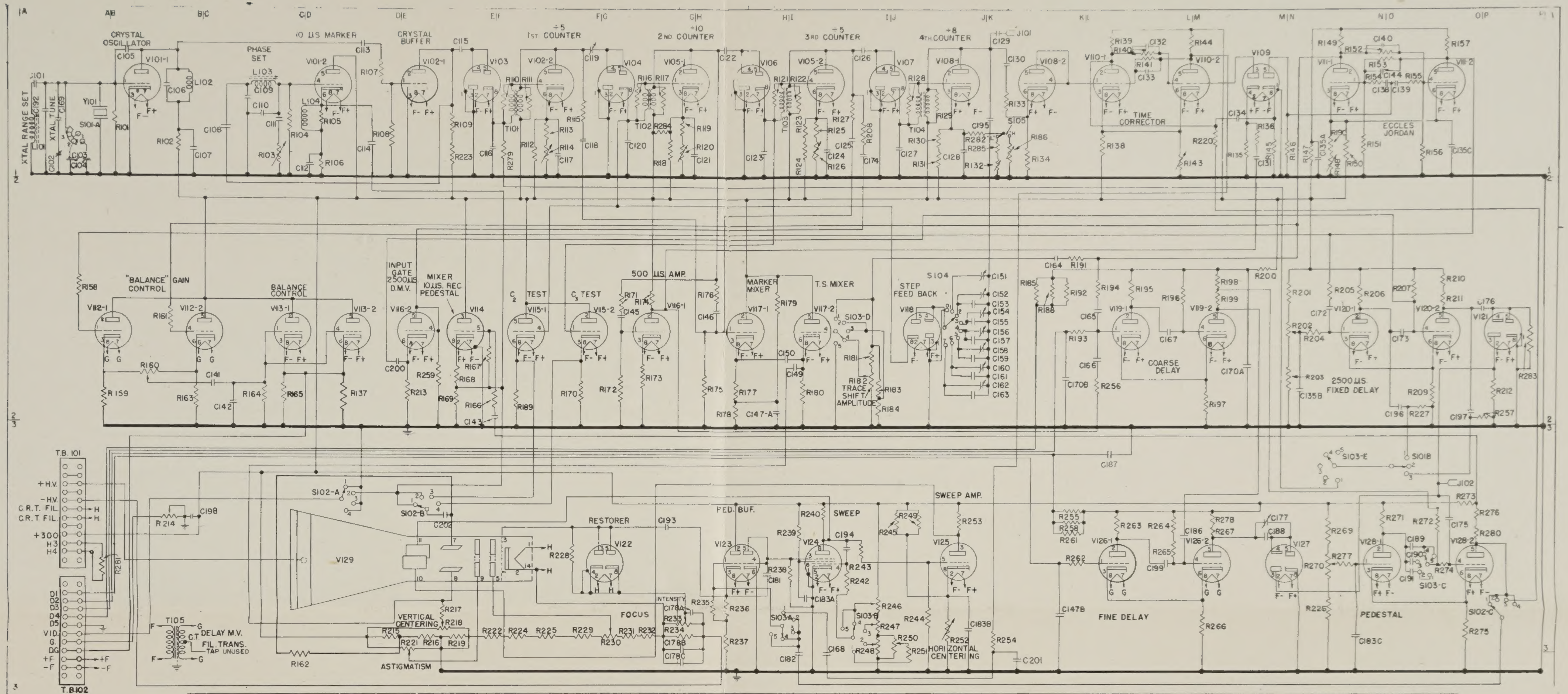

RECEIVER UNIT
TB 401
VID
GND
G
DG
+300
+F
−F
H1
H2
L306
INDICATOR UNIT
TB101
+HV
−HV
CRT. FIL.
CRT. FIL.
+300
H3
H4
TB 102
D1
D2
D3
D4
D5
VID
G
DG
+F
−F
TB 301
A2
A1
B1
B2
H1
H2
TB 303
D1
D2
D3
D4
D5
VID
G
DG
H3
H4
POWER SUPPLY UNIT
TB 302
−F
+F
+300
CRT. FIL.
CRT. FIL.
−HV
+HV
CABLE BETWEEN POWER AND INDICATOR UNITS
NOTE - HEAVIER LINES ARE TO FACILITATE TRACING WIRES BETWEEN TERMINAL BOARDS.

Figure 7-28—Unit Interconnections



SWITCH	POSITION NUMBER	PANEL MARKING
S101-A, B LEFT-RIGHT	1 2	LEFT RIGHT
S103-A, B, C, D, E RECEIVER	1 2 3 4	OFF ON CAL. 1 CAL. 2

SYMBOL	[illegible]	DESCRIPTION
C101	A1	CAP MICA 3800 MMF ±5% 500 V.
C102	A1	AIR TRIMMER 50 MMFD MAX.
C103	A1	CERAMIC 1.5 MMFD O.T.C. ±20%
C104	A1	CERAMIC 2.2 MMFD O.T.C. ±20%
C105	B1	CERAMIC 4.7 MMFD O.T.C. ±10%
C106	B1	SILVER MICA 300 MMF ±5% 500 V
C107	B1	PAPER 6,000 MMF ±20% 600 V
C108	C1	CERAMIC 47 MMFD ±10% O.T.C.
C109	C1	MICA 390 MMFD ±5% 500 V.
C110	C1	MICA 200 MMFD ±5% 500 V
C111	C1	MICA 200 MMFD ±5% 500 V
C112	D1	MOULDED PAPER .01 MFD ±20% 400 V.
C113	D1	MICA 330 MMFD ±10% 500 V
C114	D1	CERAMIC 47 MMF ±10% O.T.C.
C115	E1	CERAMIC 33 MMFD ±10% O.T.C.
C116	E1	MICA 510 MMFD ±5% 500 V
C117	F1	PAPER .5 MFD ±10% 600 V.
C118	F1	CERAMIC 68 MMFD O.T.C. ±10%
C119	F1	AIR TRIMMER 68 MMFD MAX.
C120	G1	MICA 2,400 MMFD ±5% 500 V
C121	H1	PAPER 10 MFD ±10% 500 V
C122	H1	CERAMIC 33 MMFD O.T.C. ±5%
C123	H1	MICA 2,400 MMFD ±5% 500 V
C124	I1	PAPER 1.0 MFD ±10% 500 V
C125	I1	CERAMIC 91 MMFD MAX. NEG ±5%
C126	I1	CERAMIC 43 MMFD ±5% O.T.C.
C127	J1	MICA 3,900 MMFD ±5% 500 V
C128	J1	PAPER 1.0 MFD ±10% 500 V
C129	K1	CERAMIC 100 MMFD MAX. NEG ±10%
C130	K1	CERAMIC 100 MMFD MAX. NEG ±10%
C131	M1	CERAMIC 47 MMFD ±5% O.T.C.
C132	L1	CERAMIC 240 MMF MAX. NEG ±5%
C133	L1	CERAMIC 240 MMF MAX. NEG ±5%
C134	M1	CERAMIC 240 MMFD MAX. NEG ±5%
C135A	N1	PAPER .1 MFD ±20% 600 V
C135B	N2	PAPER .1 MFD ±20% 600 V
C135C	O1	PAPER .1 MFD ±20% 600 V
C138	N1	CERAMIC 10 MMF O.T.C. ±5%
C139	O1	CERAMIC 10 MMF O.T.C. ±5%
C140	N1	CERAMIC 27 MMFD ±5% O.T.C.
C141	C2	PAPER .5 MFD ±10% 600 V
C142	C2	MICA 1,000 MMF ±10% 500 V
C143	E2	MOULDED PAPER .01 MFD ±20% 400 V
C144	N1	CERAMIC 27 MMFD ±5% O.T.C.
C145	G2	CERAMIC 27 MMF ±10% O.T.C.
C146	H2	CERAMIC 51 MMF ±5% MAX. NEG.
C147A	H2	PAPER .1 MFD ±20% 600 V
C147B	K3	PAPER 2 X .1 MFD ±20% 600 V
C149	I2	PAPER .5 MFD ±10% 600 V
C150	I2	MICA 390 MMFD ±5% 500 V
C151	J2	AIR 50 MMF STATION SELECTOR
C152	J2	AIR 50 MMF STATION SELECTOR
C153	J2	CERAMIC 22 MMF ±5%
C154	J2	AIR 50 MMF STATION SELECTOR
C155	J2	CERAMIC 51 MMF ±5%
C156	J2	AIR 50 MMF STATION SELECTOR
C157	J2	CERAMIC 75 MMF ±5%
C158	J2	AIR 50 MMF STATION SELECTOR
C159	J2	CERAMIC 100 MMF
C160	J2	AIR 50 MMF STATION SELECTOR
C161	J2	CERAMIC 130 MMF ±5%
C162	J2	CAP AIR 50 MMF STATION SELECTOR

SYMBOL	[illegible]	DESCRIPTION
C163	J2	CAP CERAMIC 160 MMF ±5%
C164	K2	PAPER .5 MFD ±10% 600 V
C165	L2	CERAMIC 220 MMF MAX. NEG ±10%
C166	L2	CERAMIC 47 MMF O.T.C. ±10%
C167	L2	MICA .03 MFD ±5% 600 V
C168	I3	PAPER .1 MFD ±10% 400 V
C169	A1	CERAMIC 100 MMF ±5% O.T.C.
C170A	M2	PAPER 2 X .1 MFD ±20% 600 V
C170B	K2	PAPER .1 MFD ±20% 600 V
C172	N2	CERAMIC 27 MMF O.T.C. ±10%
C173	O2	MICA .01 MFD ±5% 300 V
C174	I1	CERAMIC 47 MMF ±10% O.T.C.
C175	I1	MICA 470 MMF ±10% 500 V.
C176	P2	MICA 680 MMF ±5% 500 V
C177	M3	CERAMIC TRIMMER 125 MMF MAX.
C178A	H3	PAPER .1 MFD ±20% 600 V
C178B	H3	PAPER .1 MFD ±20% 600 V
C178C	H3	PAPER .1 MFD ±20% 600 V
C181	H3	PAPER .1 MFD ±10% 400 V
C182	I3	PAPER .1 MFD ±10% 400 V
C183A	I3	PAPER .1 MFD ±20% 600 V
C183B	J3	PAPER .1 MFD ±20% 600 V
C183C	N3	PAPER .1 MFD ±20% 600 V
C186	M3	MICA 470 MMF ±10% 500 V
C187	L3	PAPER 1.0 MFD ±10% 500 V
C188	M3	CERAMIC 110 MMF ±5% O.T.C.
C189	O3	MICA 360 MMF ±5% 500 V
C190	O3	MICA 1300 MMF ±5% 500 V
C191	O3	MICA 3,600 MMF ±5% 500 V
C192	A1	CERAMIC 51 MMF ±5% O.T.C.
C193	G3	PAPER .1 MFD 3000 V
C194	I3	MICA 1,000 MMFD 500 V ±5%
C195	K1	PAPER 6,000 MMF ±20% 600 V.
C196	O2	PAPER .1 MFD ±10% 400 V
C197	O2	PAPER .1 MFD ±10% 400 V.
C198	B3	PAPER 1.0 MFD 500 V ±10%
C199	L3	MICA 1,500 MMFD ±5% 500 V
C200	D2	CAP MICA 470 MMF ±10% 500 V
C201	K3	CAP MICA 470 MMF ±10% 500 V
C202	E3	CAP PAPER .1 MFD - 10% 400 V
R101	B1	RES 120,000 Ω ±10% 1/2 W
R102	B1	RES 2,200 Ω ±10% 1 W
R103	C1	POT 2 MEG ±20% TAPERED
R104	C1	RES 1 MEG Ω ±10% 1/2 W
R105	D1	750 Ω ±5% 1/2 W
R106	D1	22,000 Ω ±10% 1 W
R107	D1	39,000 Ω ±10% 1/2 W
R108	D1	100,000 Ω ±10% 1/2 W
R109	E1	10,000 Ω ±10% 1 W
R110	E1	11,000 Ω ±5% 1 W
R111	F1	4,700 Ω ±5% 1 W
R112	F1	180,000 Ω ±5% 1 W
R113	F1	RES 1,000 Ω ±10% 1 W
R114	F1	POT W.W. 10,000 Ω ±10% 2 W
R115	F1	RES 30,000 Ω ±5% 1/2 W
R116	G1	11,000 Ω ±5% 1 W
R117	G1	4,700 Ω ±5% 1 W
R118	G1	150,000 Ω ±10% 1 W
R119	G1	RES 8,200 Ω ±10% 1 W
R120	G1	POT W.W. 10,000 Ω ±10% 2 W
R121	H1	RES 11,000 Ω ±5% 1 W
R122	I1	RES 4,700 Ω ±5% 1 W

SYMBOL	[illegible]	DESCRIPTION
R123	I1	RES 36,000 Ω ±5% 1 W
R124	I1	RES 39,000 Ω ±5% 1 W
R125	I1	RES 8,200 Ω ±10% 1 W
R126	I1	POT W.W. 10,000 Ω ±10% 2 W.
R127	I1	RES 15,000 Ω ±10% 1/2 W
R128	J1	RES 11,000 Ω ±5% 1 W.
R129	J1	RES 4,700 Ω ±5% 1 W
R130	J1	RES 39,000 Ω ±10% 1 W
R131	J1	RES 33,000 Ω ±10% 1 W
R132	J1	POT W.W. 10,000 Ω ±10% 2 W
R133	K1	RES 22,000 Ω ±10% 1/2 W
R134	K1	91,000 Ω ±5% 1/2 W
R135	M1	91,000 Ω ±5% 1/2 W
R136	M1	100,000 Ω ±10% 1/2 W
R137	D2	4,700 Ω ±10% 1 W
R138	L1	180,000 Ω ±5% 1 W
R139	L1	39,000 Ω ±5% 1 W
R140	L1	390,000 Ω ±5% 1/2 W
R141	L1	390,000 Ω ±5% 1/2 W
R143	L1	POT 10,000 Ω ±10% 4 W W.W.
R144	L1	RES 39,000 Ω ±5% 1 W
R145	M1	RES 150,000 Ω ±10% 1/2 W
R146	M1	RES 150,000 Ω ±10% 1/2 W
R147	N1	RES 2,200 Ω ±10% 1 W
R148	N1	POT 5,000 Ω ±10% 2 W W.W.
R149	N1	RES 39,000 Ω ±5% 1 W
R150	N1	160,000 Ω ±5% 1 W
R151	N1	91,000 Ω ±5% 1/2 W
R152	N1	390,000 Ω ±5% 1/2 W
R153	N1	390,000 Ω ±5% 1/2 W
R154	N1	33,000 Ω ±10% 1/2 W
R155	O1	33,000 Ω ±10% 1/2 W
R156	O1	91,000 Ω ±5% 1/2 W
R157	O1	39,000 Ω ±5% 1 W
R158	A2	1.5 MEG Ω ±10% 1/2 W
R159	A2	RES 470,000 Ω ±10% 1 W
R160	B2	POT CARBON 500,000 Ω ±20%
R161	B2	RES 1.5 MEG Ω ±10% 1/2 W
R162		1 MEG Ω ±10% 1/2 W
R163	B2	RES 470,000 Ω ±10% 1 W
R164	C2	2.7 MEG Ω ±10% 1/2 W
R165	C2	4700 Ω ±5% 1 W
R166	E2	100,000 Ω ±10% 1/2 W
R167	E2	2.7 MEG Ω ±10% 1/2 W
R168	E2	39,000 Ω ±10% 1 W
R169	E2	180,000 Ω ±10% 1 W
R170	F2	56,000 Ω ±10% 1 W
R171	G2	100,000 Ω ±10% 1/2 W
R172	G2	56,000 Ω ±10% 1/2 W
R173	G2	4,700 Ω ±10% 1/2 W
R174	G2	22,000 Ω ±10% 1 W
R175	H2	100,000 Ω ±10% 1/2 W
R176	H2	24,000 Ω ±5% 1/2 W
R177	H2	4,700 Ω ±5% 1 W
R178	H2	12,000 Ω ±10% 1 W
R179	H2	240,000 Ω ±5% 1 W
R180	I2	100,000 Ω ±10% 1 W
R181	I2	RES 1 MEG Ω ±10% 1/2 W
R182	I2	POT 2 MEG Ω ±20%
R183	I2	RES 1.2 MEG Ω ±5% 1/2 W
R184	I2	RES 1.6 MEG Ω ±5% 1/2 W

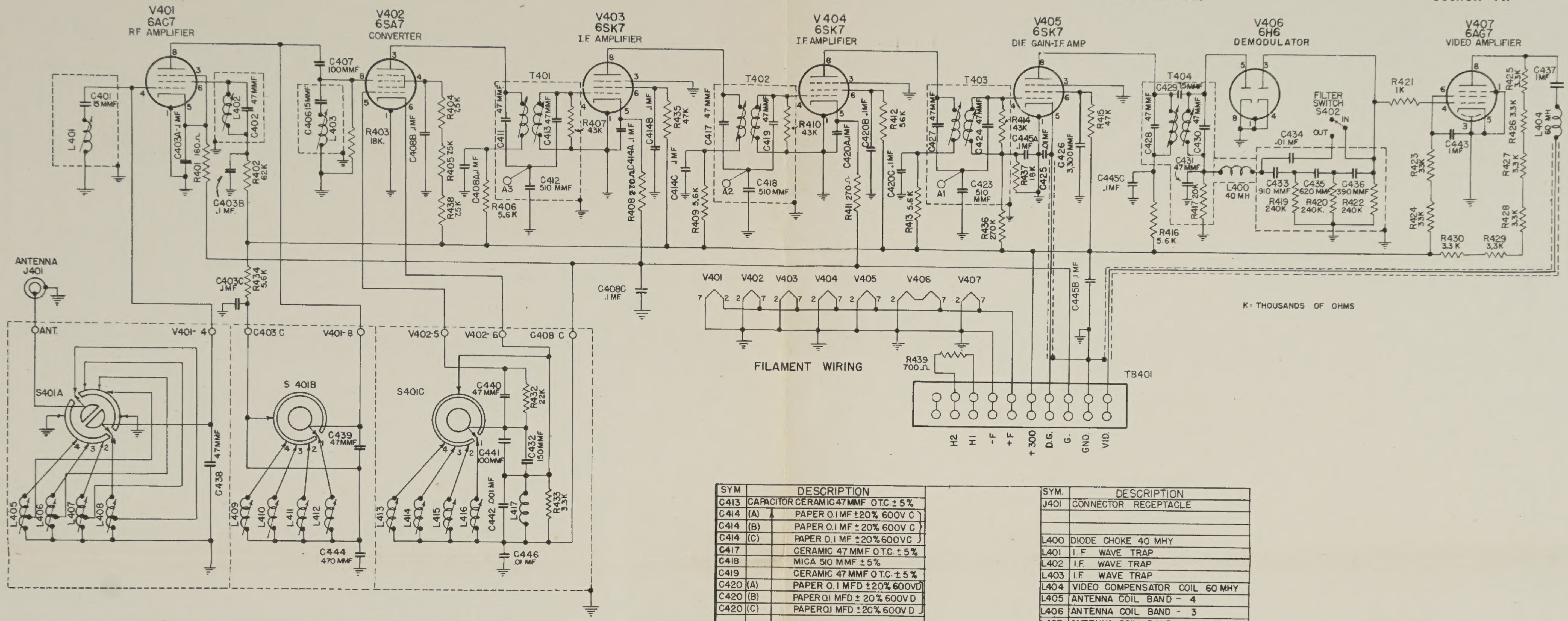
SYMBOL	[illegible]	DESCRIPTION
R185	K2	RES 200,000 Ω ±5% 1 W
R186	K1	POT W.W. 10000 Ω ±10%
R187		
R188	K2	200,000 Ω ±5% 1 W
R189	F2	56,000 Ω ±10% 1 W
R190	N1	3,900 Ω ±5% 1 W
R191	K2	82,000 Ω ±10% 1/2 W.
R192	K2	200,000 Ω ±5% 1 W
R193	L2	100,000 Ω ±10% 1/2 W
R194	L2	33,000 Ω ±10% 1/2 W
R195	L2	20,000 Ω ±5% 1 W
R196	L2	3.3 MEG Ω ±5% 1 W
R197	M2	12,000 Ω ±5% 1 W
R198	M2	10,000 Ω ±5% 1 W
R199	M2	10,000 Ω ±5% 1 W
R200	M2	2,200 Ω ±10% 1 W
R201	N2	RES 220,000 Ω ±5% 1 W
R202	N2	POT W.W. 10,000 Ω ±10%
R203	N2	RES 10,000 Ω ±5% 1 W
R204	N2	100,000 Ω ±10% 1/2 W
R205	N2	27,000 Ω ±10% 1/2 W
R206	N2	20,000 Ω ±5% 1 W
R207	O2	3.9 MEG Ω ±5% 1 W
R208	I1	56,000 Ω ±10% 1/2 W
R209	O2	10,000 Ω ±5% 1 W
R210	O2	10,000 Ω ±5% 1 W
R211	O2	10,000 Ω ±5% 1 W
R212	P2	330,000 Ω ±10% 1/2 W
R213	E2	330,000 Ω ±10% 1/2 W
R214	B3	2,000-4 W W.W. POT. TAP ±10%
R215	D3	330000 Ω ±10% 1/2 W
R216	E3	330,000 Ω ±10% 1 W
R217	E3	RES 1.5 MEG Ω ±10% 1/2 W
R218	E3	POT CARBON 2.0 MEG Ω ±20%
R219	E3	RES 330,000 Ω ±10% 1 W
R220	M1	RES 100,000 Ω ±10% 1/2 W
R221	E3	POT 2 MEG Ω ±20% CARBON
R222	E3	RES 330,000 Ω ±5% 1 W
R223	E1	10,000 Ω ±10% 1 W
R224	F3	470,000 Ω ±5% 1 W
R225	F3	470,000 Ω ±5% 1 W
R226	N3	36,000 Ω ±5% 1 W
R227	O2	4.7 MEG Ω ±10% 1/2 W
R228	F3	2.7 MEG Ω ±10% 1 W
R229	F3	RES 330,000 Ω ±5% 1 W
R230	G3	POT CARBON 750,000 Ω ±10%
R231	G3	RES 270,000 Ω ±5% 1 W
R232	G3	RES 240,000 Ω ±5% 1 W
R233	G3	POT CARBON 500,000 Ω ±10%
R234	G3	RES 470,000 Ω ±10% 1 W
R235	H3	220,000 Ω ±10% 1/2 W
R236	H3	9,100 Ω ±5% 1/2 W
R237	H3	100,000 Ω ±10% 1 W
R238	H3	2.7 MEG Ω ±10% 1/2 W
R239	I3	68,000 Ω ±5% 1 W
R240	I3	39,000 Ω ±5% 1 W
R242	I3	180,000 Ω ±5% 1 W
R243	I3	620,000 Ω ±5% 1 W
R244	J3	43,000 Ω ±5% 1/2 W
R245	J3	RES 180,000 Ω ±10% 1 W
R246	I3	POT CARBON 100,000 Ω ±20%

SYMBOL	[illegible]	DESCRIPTION
R247	I3	POT CARB 100,000 Ω ±20%
R248	I3	POT CARB 50,000 Ω ±20%
R249	J3	RES 180,000 Ω ±10% 1 W
R250	J3	POT 50,000 Ω ±20% CARB
R251	J3	RES 3.6 MEG Ω ±5% 1/2 W
R252	J3	POT W.W. 10,000 Ω ±10%
R253	J3	RES 160,000 Ω ±5% 1 W
R254	K3	RES 100,000 Ω ±10% 1/2 W
R255	K3	RES 200,000 Ω ±5% 1 W
R256	L2	RES 150,000 Ω ±10% 1/2 W
R257	P2	RES 4.7 MEG Ω ±10% 1/2 W
R258	K3	RES 200,000 Ω ±5% 1 W
R259	E2	270,000 Ω ±10% 1/2 W
R261	K3	200,000 Ω ±5% 1 W
R262	K3	100,000 Ω ±10% 1/2 W
R263	L3	20,000 Ω ±5% 1 W
R264	L3	1.2 MEG Ω ±5% 1 W
R265	L3	1.2 MEG Ω ±5% 1 W
R266	M3	10,000 Ω ±5% 1 W
R267	M3	RES 10,000 Ω ±5% 1 W
R269	N3	RES 180,000 Ω ±10% 1 W
R270	N3	POT 10,000 Ω ±10% W.W.
R271	O3	RES 10,000 Ω ±5% 1 W
R272	O3	3.9 MEG Ω ±5% 1 W
R273	O3	2,000 Ω ±5% 1 W
R274	O3	100,000 Ω ±5% 1/2 W
R275	O3	6,800 Ω ±5% 1 W
R276	P3	3,600 Ω ±5% 1 W
R277	N3	100,000 Ω ±10% 1/2 W
R278	M3	10,000 Ω ±5% 1 W
R279	F1	560,000 Ω ±10% 1/2 W
R280	P3	4,300 Ω ±5% 1 W
R281	A3	700 Ω ±10% 30 W
R282	J1	11,000 Ω ±5% 1 W
R283	P2	330,000 Ω ±10% 1/2 W
R284	G1	RES 180,000 Ω ±5% 1 W
R285	K1	RES 39,00 Ω ±5% 1 W
		(NOTE - R285 ON UNITS AFTER SERIAL NO. 770 ONLY)
S105	K1	PRR SWITCH DPDT
T101	F1	BLOCKING OSC. TRANSFORMER
T102	G1	BLOCKING OSC. TRANSFORMER
T103	H1	BLOCKING OSC. TRANSFORMER
T104	J1	BLOCKING OSC. TRANSFORMER
T105	B3	HEATER TRANSFORMER
L101	A1	OSCILLATOR GRID COIL
L102	B1	OSCILLATOR PLATE COIL 6 MHY
L103	C1	PHASE SHIFT COIL 13.5 MHY
L104	C1	PIP COIL 2 MHY
S101-A	A1	CRYSTAL FREQ. CHANGE SWITCH
S101-B	O3	FRAMING SWITCH
S102-A	D3	RECEIVER SWITCH
S102-B	E3	TEST SWITCH
S102-C	P3	SWEEP SELECTOR
S103-A	H3	SWEEP INPUT SWITCH
S103-B	I3	SWEEP SPEED SWITCH
S103-C	O3	PEDESTAL LENGTH SWITCH
S103-D	I2	TRACE SHIFT SWITCH
S103-E	N3	FRAMING INPUT SWITCH

SYMBOL	[illegible]	DESCRIPTION
S104	J2	STATION SELECTOR SWITCH
V101-1	B1	TUBE CRYSTAL OSC. 6SL7GT
V101-2	D1	10 US PIP MAKER
V102-1	E1	100 KC BUFFER 6SN7GT
V102-2	F1	1ST BLOCKING OSC.
V103	E1	1ST COUNTER GATE 6H6GT
V104	G1	2ND COUNTER GATE 6H6GT
V105-1	G1	2ND BLOCKING OSC. 6SN7GT
V105-2	I1	3RD BLOCKING OSC.
V106	H1	3RD COUNTER GATE 6H6GT
V107	I1	4TH COUNTER GATE 6H6GT
V108-1	J1	4TH BLOCKING OSC. 6SN7GT
V108-2	K1	E.J. INPUT GATE
V109	M1	T.C.E.J. INPUT GATE 6H6GT
V110-1	L1	TIME CORRECTOR E.J. 6SN7GT
V110-2	L1	TIME CORRECTOR E.J.
V111-1	N1	E.J. 25 US SQ. WAVE MAKER 6SN7GT
V111-2	O1	E.J. 25 US SQ. WAVE MAKER
V112-1	A2	GAIN BALANCE AMP. 6SL7GT
V112-2	B2	GAIN BALANCE AMP.
V113-1	C2	GAIN BALANCE CONTROL 6SN7GT
V113-2	D2	REFERENCE DIODE
V114	E2	10 US REC. & PED. MIXER 6J5GT
V115-1	F2	COUNTER TEST 6SL7GT
V115-2	F2	COUNTER TEST
V116-1	G2	500 US TIMER AMP. 6SL7GT.
V116-2	E2	INPUT GATE FIXED DMV.
V117-1	H2	50, 500, 2500 µS MIXER 6SL7GT
V117-2	J2	TRACE SHIFT MIXER
V118	J2	STEP FEED BACK GATE 6H6GT
V119-1	L2	COARSE DELAY M.V. 6SN7GT
V119-2	M2	COARSE DELAY M.V.
V120-1	N2	2,500 µS FIXED DELAY M.V. 6SL.
V120-2	O2	2,500 µS FIXED DELAY M.V.
V121	P2	PED. INPUT GATE 6H6GT
V122	F3	C.R. BLANKING REST. 6H6GT
V123-1	H3	SWEEP INPUT GATE 6SN7GT
V123-2	H3	SWEEP INPUT GATE
V124	I3	SWEEP GENERATOR 6SK7
V125	J3	SWEEP AMPL. 6J5GT
V126-1	L3	FINE DELAY M.V. 6SN7GT
V126-2	M3	FINE DELAY M.V.
V127	N3	PEDESTAL INPUT 6H6GT
V128-1	N3	PEDESTAL GENER. 6SN7GT
V128-2	P3	PEDESTAL GENER.
V129	O3	TUBE C.R. TUBE 5CP1
Y101	A1	100 K.C. CRYSTAL
TB101	A3	TERMINAL BOARD
TB102	A3	TERMINAL BOARD
J101	K1	JACK 50 CYCLES SYNC OUTPUT
J102	O3	JACK SYNC FOR TRAINER

NOTE *1 - ON DAS AND DAS-1 USE C--6SK7, PT. 232; ON DAS-2 USE C--6SJ7, PT. 230.

Figure 7-27—Indicator Unit Schematic Diagram


V401
6AC7
RF AMPLIFIER
V402
6SA7
CONVERTER
V403
6SK7
I.F. AMPLIFIER
V404
6SK7
I.F. AMPLIFIER
V405
6SK7
DIF. GAIN-I.F. AMP
V406
6H6
DEMODULATOR
V407
6AG7
VIDEO AMPLIFIER
T401
T402
T403
T404
FILTER SWITCH S402
IN
OUT
ANTENNA J401
ANT.
S401A
S 401B
S401C
V401-4
V401-8
C403 C
V402-5
V402-6
C408 C
FILAMENT WIRING
R439 700 Ω
TB401
H2
H1
-F
+F
+300
D.G.
G.
GND.
VID.
K: THOUSANDS OF OHMS

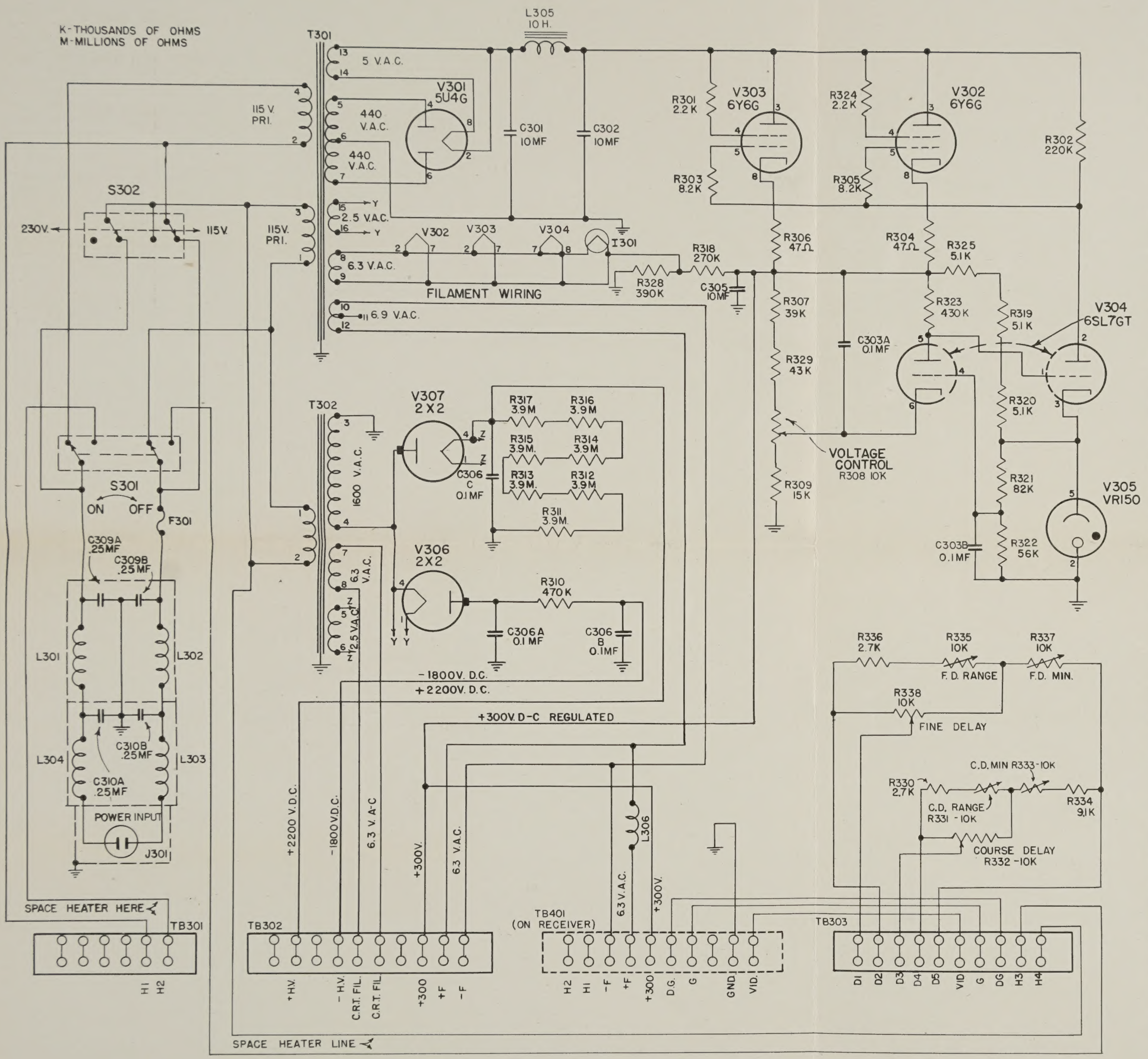
SYM.	DESCRIPTION
	UNLESS OTHERWISE SPECIFIED ALL
	RESISTORS INSULATED CARBON TYPE.
R401	RESISTOR 160 Ω ±5% 1/2 W.
R402	62,000 Ω ±5% 1W.
R403	18,000 Ω ±5% 1/2 W.
R404	7,500 Ω ±5% 1W.
R405	7,500 Ω ±5% 1W.
R406	5,600 Ω ±10% 1W.
R407	43,000 Ω ±5% 1/2 W.
R408	270 Ω ±5% 1/2 W.
R409	5,600 Ω ±10% 1W.
R410	43,000 Ω ±5% 1/2 W.
R411	270 Ω ±5% 1/2 W.
R412	56,000 Ω ±5% 1W.
R413	5,600 Ω ±10% 1W.
R414	43,000 Ω ±5% 1/2 W.
R415	47,000 Ω ±5% 1W.
R416	5,600 Ω ±10% 1W.
R417	20,000 Ω ±5% 1/2 W.
R418	
R419	240,000 Ω ±5% 1/2 W.
R420	240,000 Ω ±5% 1/2 W.
R421	1000 Ω ±10% 1/2 W.
R422	240,000 Ω ±5% 1/2 W.
R423	RESISTOR 33,000 Ω ±10% 1W.

SYM.	DESCRIPTION
R424	RESISTOR 33,000 Ω ±10% 1W.
R425	3,300 Ω ±5% 1W.
R426	3,300 Ω ±5% 1W.
R427	3,300 Ω ±5% 1W.
R428	3,300 Ω ±5% 1W.
R429	3,300 Ω ±5% 1W.
R430	3,300 Ω ±5% 1W.
R431	
R432	22,000 Ω ±5% 1/2 W.
R433	3,300 Ω ±5% 1W.
R434	5,600 Ω ±10% 1W.
R435	47,000 Ω ±5% 1W.
R436	270,000 Ω ±5% 1W.
R437	18,000 Ω ±5% 1/2 W.
R438	7,500 Ω ±5% 1W.
R439	RESISTOR 700 Ω ±10% 30W. W.W.
C401	CAPACITOR CERAMIC 15 MMF O.T.C. ±5%
C402	CERAMIC 47 MMF O.T.C. ±5%
C403	(A) PAPER 0.1 MF ±20% 600V A
C403	(B) PAPER 0.1 MF ±20% 600V A
C403	(C) PAPER 0.1 MF ±20% 600V A
C406	CERAMIC 15 MMF O.T.C. ±5%
C407	MICA 100 MMF ±5% 500V.
C408	(A) PAPER 0.1 MF ±20% 600V B
C408	(B) PAPER 0.1 MF ±20% 600V B
C408	(C) PAPER 0.1 MF ±20% 600V B
C411	CERAMIC 47 MMF O.T.C. ±5%
C412	CAPACITOR MICA 510 MMF ±5%

SYM	DESCRIPTION
C413	CAPACITOR CERAMIC 47 MMF O.T.C. ±5%
C414	(A) PAPER 0.1 MF ±20% 600V C
C414	(B) PAPER 0.1 MF ±20% 600V C
C414	(C) PAPER 0.1 MF ±20% 600V C
C417	CERAMIC 47 MMF O.T.C. ±5%
C418	MICA 510 MMF ±5%
C419	CERAMIC 47 MMF O.T.C. ±5%
C420	(A) PAPER 0.1 MFD ±20% 600V D
C420	(B) PAPER 0.1 MFD ±20% 600V D
C420	(C) PAPER 0.1 MFD ±20% 600V D
C423	MICA 510 MMF ±5%
C424	CERAMIC 47 MMF O.T.C. ±5%
C425	PAPER .01 MF ±20% 400V.
C426	MICA 3,300 MMF ±10%
C427	CERAMIC 47 MMFD O.T.C. ±5%
C428	CERAMIC 47 MMFD O.T.C. ±5%
C429	CERAMIC 7.5 MMFD ±5% O.T.C.
C430	CERAMIC 47 MMF O.T.C. ±5%
C431	CERAMIC 47 MMF O.T.C. ±5%
C432	CERAMIC 150 MMF ±5%
C433	S. MICA 910 MMF ±5% 300V.
C434	M. PAPER .01 MF ±20% 400V.
C435	S. MICA 620 MMF ±5% 300V.
C436	S. MICA 390 MMF ±5%
C437	PAPER 1 MF ±10% 500V.
C438	CERAMIC 47 MMF O.T.C. ±5%
C439	CERAMIC 47 MMF O.T.C. ±5%
C440	CERAMIC 47 MMF O.T.C. ±5%
C441	CERAMIC 100 MMF ±5%
C442	S. MICA 1,000 MMF ±5% 500V.
C443	PAPER 1 MFD ±10% 500V.
C444	MICA 470 MMF ±10% 500V.
C445	(A) PAPER 0.1 MFD ±20% 600V E
C445	(B) PAPER 0.1 MFD ±20% 600V E
C445	(C) PAPER 0.1 MFD ±20% 600V E
C446	CAPACITOR PAPER .01 MF ±20% 400V
V401	TUBE R.F. AMP.
V402	CONVERTER
V403	I.F. AMPLIFIER
V404	I.F. AMPLIFIER
V405	DIF. GAIN - I.F. AMP.
V406	DEMODULATOR
V407	TUBE VIDEO AMPLIFIER

SYM.	DESCRIPTION
J401	CONNECTOR RECEPTACLE
L400	DIODE CHOKE 40 MHY
L401	I.F. WAVE TRAP
L402	I.F. WAVE TRAP
L403	I.F. WAVE TRAP
L404	VIDEO COMPENSATOR COIL 60 MHY
L405	ANTENNA COIL BAND - 4
L406	ANTENNA COIL BAND - 3
L407	ANTENNA COIL BAND - 2
L408	ANTENNA COIL BAND - 1
L409	CONVERTER COIL - BAND - 4
L410	CONVERTER COIL - BAND - 3
L411	CONVERTER COIL - BAND - 2
L412	CONVERTER COIL - BAND - 1
L413	OSCILLATOR COIL - BAND - 4
L414	OSCILLATOR COIL - BAND - 3
L415	OSCILLATOR COIL - BAND - 2
L416	OSCILLATOR COIL - BAND - 1
L417	OSCILLATOR COIL -CHOKE
S401A	ANTENNA BAND SWITCH
S401B	CONVERTER BAND SWITCH
S401C	OSCILLATOR BAND SWITCH
S402	FILTER SWITCH
T401	I.F. TRANSFORMER
T402	I.F. TRANSFORMER
T403	I.F. TRANSFORMER
T404	I.F. TRANSFORMER

Figure 7-26—Receiver Unit Schematic Diagram


K-THOUSANDS OF OHMS
M-MILLIONS OF OHMS
T301
L305
10 H.
5 V.A.C.
13
14
115 V.
PRI.
440
V.A.C.
440
V.A.C.
V301
5U4G
C301
10MF
C302
10MF
S302
230V.
115V.
115V.
PRI.
2.5 V.A.C.
Y
Y
6.3 V.A.C.
V302
V303
V304
I301
FILAMENT WIRING
6.9 V.A.C.
R328
390K
R318
270K
C305
10MF
R301
2.2K
V303
6Y6G
R303
8.2K
R324
2.2K
V302
6Y6G
R305
8.2K
R302
220K
R306
47Ω
R304
47Ω
R325
5.1K
R307
39K
R329
43K
R309
15K
C303A
0.1MF
R323
430K
R319
5.1K
V304
6SL7GT
R320
5.1K
VOLTAGE
CONTROL
R308 10K
R321
82K
V305
VR150
C303B
0.1MF
R322
56K
T302
1600 V.A.C.
6.3
V.A.C.
2.5 V.A.C.
V307
2X2
R317
3.9M
R316
3.9M
R315
3.9M.
R314
3.9M
R313
3.9M.
R312
3.9M
R311
3.9M.
C306
C
0.1MF
V306
2X2
R310
470K
C306A
0.1 MF
C306
B
0.1MF
-1800V. D.C.
+2200V. D.C.
+300V. D-C REGULATED
S301
ON
OFF
F301
C309A
.25MF
C309B
.25MF
L301
L302
L304
L303
C310B
.25MF
C310A
.25MF
POWER INPUT
J301
SPACE HEATER HERE
TB301
H1
H2
+2200 V.D.C.
-1800V.D.C.
6.3 V. A-C
+300V.
6.3 V.A.C.
6.3 V.A.C.
L306
+300V.
TB302
+H.V.
-H.V.
C.R.T. FIL.
C.R.T. FIL.
+300
+F
-F
TB401
(ON RECEIVER)
H2
H1
-F
+F
+300
D.G.
G
GND.
VID.
R336
2.7K
R335
10K
F.D. RANGE
R337
10K
F.D. MIN.
R338
10K
FINE DELAY
C.D. MIN R333-10K
R330
2.7K
C.D. RANGE
R331 -10K
R334
9.1K
COURSE DELAY
R332 -10K
TB303
D1
D2
D3
D4
D5
VID
G
DG
H3
H4
SPACE HEATER LINE

SYM.	DESCRIPTION
	UNLESS OTHERWISE SPECIFIED ALL
	RESISTORS ARE INSULATED CARBON
R301	RESISTOR 2200 Ω ±10% ½ W.
R302	↑ 220,000Ω ±5% 1W.
R303	8,200Ω ±10% ½W
R304	47 Ω ±10% 1W.
R305	8,200 Ω ±10% ½W.
R306	↓ 47Ω ±10% 1W.
R307	RESISTOR 39000 Ω ±5% 1W.
R308	POTENTIOMETER 10,000Ω ±10% WW
R309	RESISTOR 15,000Ω ±5% 1W
R310	↑ 470,000 Ω ±10% 1W
R311	3.9 MEG Ω ±10% 1W
R312	3.9 MEG Ω ±10% 1W
R313	3.9 MEG Ω ±10% 1W
R314	3.9 MEG Ω ±10% 1W
R315	3.9 MEG. Ω ±10% 1W
R316	3.9 MEG. Ω ±10% 1W
R317	3.9 MEG Ω ±10% 1W
R318	270,000Ω ±10% 1W
R319	5,100Ω ±5% 1W
R320	5,100Ω ±5% 1W
R321	82,000 ±5% ½W
R322	56,000Ω ±5% ½W.
R323	430,000Ω ±5% 1W.
R324	↓ 2,200Ω ±10% ½W.
R325	RESISTOR 5,100 Ω ±5% 1W.
R326	
R327	
R328	RESISTOR 390,000 Ω ±10% 1W.
R329	RESISTOR 43,000Ω ±5% 1W.
R330	RESISTOR 2700 Ω ±5% 1W.
R331	POTENTIOMETER 10,000Ω ±10% WW 2W
R332	POTENTIOMETER 10,000Ω ±5% WW 4W
R333	POTENTIOMETER 10,000 Ω ±10% WW 2W
R334	RESISTOR 9,100 Ω ±5% 1W
R335	POTENTIOMETER 10,000 Ω ±10% WW 2W
R336	RESISTER 2,700 Ω ±5% 1W.
R337	POTENTIOMETER 10,000 Ω ±10% WW 2W
R338	POTENTIOMETER 10,000Ω ±5% 4 W
C301	CAPACITOR - PAPER 10MFD ±10% 1000V.
C302	↑ ↑ 10 MFD ±10% 600 V.
C303	(A) 0.1 MFD ±15% 600V.
C303	(B) 0.1 MFD ±15% 600V
C305	10 MFD ±10% 600V
C306	(A) 0.1 MFD ±10% 3000V.
C306	(B) 0.1 MFD ±10% 3000V.
C306	(C) 0.1 MFD ±10% 3000V.
C309	(A) 0.25MFD ±20% 600V
C309	(B) 0.25MFD ±20% 600V
C310	(A) ↓ ↓ 0.25MFD ±20% 600V
C310B	CAPACITOR PAPER 0.25 MFD ±20% 600V.
F301	FUSE FOR 115V 5A LITTLE FUSE 1094 OR EQUIV.
	FUSE FOR 230V-2.0A LITTLE FUSE 1094 OR EQUIV.
L301	FILTER COIL (LINE)
L302	↑ ↑ ↑
L303	↓ ↓ ↓
L304	FILTER COIL (LINE)
L305	FILTER REACTOR - 10HY. 180 MA.
L306	FILAMENT CHOKE

SYM	DESCRIPTION
PL301	CONNECTOR RECEPTACLE
S301	SWITCH-D.P.D.T. TOGGLE "ON" "OFF"
S302	SWITCH-D.P.D.T. 115V-230V.
T301	TRANSFORMER-POWER
T302	TRANSFORMER-H.V.
TB301	JUNCTION BOARD
TB302	TERMINAL BOARD HIGH VOLTAGE
TB303	TERMINAL BOARD LOW VOLTAGE
V301	TUBE 5U4G RECTIFIER
V302	↑ 6Y6G REGULATOR
V303	6Y6G REGULATOR
V304	6SL7GT REG. AMPLIFIER
V305	VR 150 VOLTAGE REG.
V306	↓ 2 X 2 H.V. RECTIFIER
V307	TUBE 2 X 2 H.V. RECTIFIER

Figure 7-25—Power Supply Unit Schematic Diagram